Citizen Working Group

In July of 2000, the Wyoming Sage-Grouse Working Group was formed to develop a statewide strategy for conservation of sage-grouse in Wyoming. After an organizational meeting June 21, 2000, potentially affected interests submitted names of potential representatives that would be acceptable to the interest groups. The working group was then selected and consisted of 18 Wyoming citizens from diverse backgrounds including agricultural, industrial, governmental, environmental, hunting, and Native American tribal interests.

Group Members Included:

Linda Baker, Pinedale; Larry Bourret, Laramie; Joel Bousman, Boulder; Tim Byer, Douglas; Tom Christiansen, Green River; Joe Evans, Cheyenne; Bill Gerhart, Cheyenne; Larry Hayden-Wing, Laramie; Larry Kmoch, Rawlins; Don Lamborn, Kemmerer; Bruce Lawson, Casper; John Marton, Buffalo; Tom Rinkes, Lander; Stacey Scott, Casper; Albert Sommers, Pinedale; Renee Taylor, Casper; Western Thayer, Ft. Washakie; and Mark Winland, Gillette. The facilitator was Bob Budd.

Many others participated in several meetings and their contributions to the planning efforts were significant. The group had numerous meetings, all open to the public and publicized via WGFD news releases and the WGFD website.

Glossary

Avoid. The term "avoid" in this document means that there is flexibility to allow an activity consistent with goals and objectives in this plan.

Crucial Habitat. Any particular seasonal range or habitat that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level over the long term.

Degraded Habitat. Habitat that is reduced in quality as a result of fragmentation, invasive plants, overgrazing/browsing, and/or shrub decadence or lack of understory due to advanced succession.

Drought. A prolonged chronic shortage of water, as compared to the norm, often associated with high temperatures and winds during spring, summer and fall or a period without precipitation during which the soil water content is reduced to such an extent that plants suffer from lack of water. (Society for Range Management)

Drought Operational Definition. Operational definitions help define the onset, severity and end of droughts. No single operational definition of drought works in all circumstances. There are four basic approaches to measuring drought: meteorological, hydrological, agricultural and socioeconomic. (National Drought Mitigation Center 1995)

> **Meteorological drought** is usually an expression of precipitation's departure from normal over some period of time.
> **Agricultural (forage) drought** occurs when there isn't enough soil moisture to meet the needs of a particular crop (including livestock production) at a particular time.
> **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, and as lake, reservoir and ground water levels.
> **Socioeconomic drought** is what happens when physical water shortage starts to affect people, individually and collectively.

Forbs. Any broad-leafed herbaceous plant, other than grasses, sedges and rushes. These are generally flowering plants with tap roots, broad leaves, netlike veins, and solid non-joint stems.

Invasive Plants. A species that is 1) primarily non-native to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Landscape. The exact boundaries or scale of a landscape are established according to the objectives of a study or discussion. The area included may be as small as a pond or as large as several counties or states, but in all cases, ecologists recognize that energy, water, nutrients, and organisms move back and forth across whatever boundaries are established. (Knight 1994)

Lek. A traditional courtship display and breeding area attended by male sage-grouse in or adjacent to sagebrush-dominated habitat. Leks are annually defined as:

> **Active.** Any lek that has been attended by male sage-grouse during the strutting season.
> **Inactive.** Leks where it is known that there was no strutting activity through the course of a strutting season.
> **Unknown.** Leks that have not been documented either active or inactive during the course of a strutting season.

Based on annual status a lek may be put into one of the following categories for management purposes:

> **Occupied Lek.** A lek that has been active during at least one strutting season within the last ten years.
> **Historic Lek.** A lek that has not been active during a consecutive ten-year period.
> **Undetermined Lek.** Any lek that has not been documented as being active in the last ten years but does not have sufficient documentation to be designated historical.

Mosaic. A landscape composed of patches of discrete ecological sites and/or seral stages in a variety of sizes and shapes.

"Newcomer" Predator. Predators that did not occur or have expanded their range in Wyoming within recent times as the result of changes in management practices and other human activities (e.g. red fox, raccoon, etc.). "Newcomer" predators may also apply to native species such as ravens which have increased in number (as apposed to range) due to human activity.

Seral Stage. The relatively transitory communities that develop under plant succession generally described as early, mid, and late seral stages. The mix of seral or successional stages on the landscape can be the result of disturbances, topography and soil, climate, uses of the land, management prescriptions, vegetation classification categories, and evaluation procedures.

Site Potential. The potential plant community that a particular area (ecological site) is capable of producing as a climax plant community.

Small-grained. A habitat or vegetation type that occurs at a much smaller scale or resolution than the overall landscape.

State-and-transition model. The idea that rangeland vegetation exhibits multiple states and transitions among them. See Bestelmeyer et al., Journal of Range Management, 56:114-126, March 2003.

List of References

Agenbroad, L. D. 1978. Buffalo jump complexes in Owyhee County, Idaho. Plains Anthropologist 23:313-321.

Anderson, J. E. and K. E. Holte. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated rangeland in southeastern Idaho. Journal of Range Management 34: 25-29.

Anderson, M. R., E. J. Depuit, R. H. Abernethy, and L. H. Kleinman. 1992. Value of mountain rye for suppression of annual bromegrass on semi-arid mined lands. Journal of Range Management 45:345-351.

Angell, R. F. 1997. Crested wheatgrass and shrub response to continuous or rotational grazing. Journal of Range Management 50:160-164.

Angelstam, P. K. 1986. Population dynamics in tetraonids: the role of extrinsic factors. Pages 2459-2477. International Ornithological Congress: Ottawa, Canada.

Angelstam, P., E. Lindstrom, and P. Widen. 1984. Role of predation in short-term population fluctuations of some birds and mammals in Fennoscandia. Oecologia 62:199-208.

Austin, D. D., and P. J. Urness. 1995. Effects of horse grazing in spring on survival, recruitment, and winter injury damage of shrubs. Great Basin Naturalist 55:267-270.

Austin, D. D., P. J. Urness, and S. L. Durham. 1994. Impacts of mule deer and horse grazing on transplanted shrubs for revegetation. Journal of Range Management 47:8-11.

Autenrieth, R. E. 1981. Sage grouse management in Idaho. Wildlife Bulletin 9. Idaho Department of Fish and Game. Boise, Idaho, USA.

Bareiss, L. J., P. Schulz, and F. S. Guthery. 1986. Effects of short-duration and continuous grazing on bobwhite and wild turkey nesting. Journal of Range Management 39:259-260.

Barnett, J. K., and J. A. Crawford. 1994. Pre-laying nutrition of sage grouse hens in Oregon. Journal of Range Management 47(2):114-118.

Barnosky, C. W., P. M. Anderson, and P. J. Bartleim. 1987. The northwestern U. S. during deglaciation: vegetational history and paleoclimate implications. Geology of North America Volume K-3. North America and adjacent oceans during the last deglaciation. The Geological Society of America.

Batterson, W. M., and W. B. Morse. 1948. Oregon sage grouse. Oregon Fauna Series 1. Oregon Game Commission, Portland, Oregon, USA.

Baxter, G. 1998. Thinning dense sagebrush stands with spike 20P. Rangelands 20:14-16.

Beatty, R. G. 1973. The DDT Myth, Triumph of the Amateurs. The John Day Company, ISBN 0-381-98242-4

Beck, T. D. 1977. Sage grouse flock characteristics and habitat selection in winter. Journal Wildlife Management 41:18-26.

Beetle, A. A. and K. L. Johnson. 1982. Sagebrush in Wyoming. Wyoming Agricultural Experimental Bulletin 779.

Belsky, A. J., A Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. Journal of Soil and Water Conservation 54:419-431.

Bennett, L. E. 1992. Soil conservation service (SCS) brush project: final report. Wyoming Fish and Wildlife Research Unit. The University of Wyoming, Laramie, Wyoming, USA.

Bennett, L. E. 1999. Current shrub management issues in Wyoming. A white paper prepared for the Wyoming Game and Fish Commission, Cheyenne, WY. 54p.

Benson, L. A., C. E. Braun, and W. C. Leininger. 1991. Sage grouse response to burning in the big sagebrush type. Proceedings, Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute 5:97-104.

Bergerud, A. T. 1985. The additive effect of hunting mortality on the natural mortality rates of grouse. Pages 345-366 in S. L. Beason and S. F. Robertson, editors. Game Harvest Management. Caesar Kleburg Wildlife Resource Institute, Kingsville, Texas.

Bergerud, A. T. 1988a. Population ecology of North American grouse. Pages 578-648 in A. T. Bergerud, and M.W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. University of Minnesota Press, Minneapolis, Minnesota, USA.

Bergerud, A. T. 1988b. Survival and breeding strategies of grouse. Pages 473-577 in A. T. Bergerud and M. W. Gratson, editors. Adaptive Strategies and population ecology on northern grouse. University of Minnesota Press, Minneapolis, USA.

Berry, J. D., and R. L. Eng. 1985. Interseasonal movements and fidelity to seasonal use areas by female sage grouse. Journal Wildlife Management 49:237-240.

Blaisdell, J. P. 1949. Composition between sagebrush seedlings and reseeded grasses. Ecology 30: 512-519.

Blaisdell, J. P. 1953. Ecological effect of planned burning of sagebrush-grass range on the upper Snake River plains. USDA Technical Bulletin 1073.

Blaisdell, J. P., R. B. Murray, and E. D. McArthur. 1982. Managing Intermountain rangelands sagebrush-grass ranges. United States Department of Agriculture, Forest Service General Technical Report, INT-134.

Blank, R. R., J. A. Young, and F. L. Allen. 1995. The soil beneath shrubs before and after wildfire: implications for revegetation. In: Proceeding: Wildland shrub and arid land restoration symposium; 1995 April. Gen. Tech. Rep. GTR-315, Ogden, Utah. USDA, Forest Service, Intermountain Forest and Range Experimental Station 173-176.

Blus, L. J., C. S. Staley, C. J. Henny, G. W. Pendleton, T. H. Craig, E. H. Craig, and D. K. Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management 53(4):1139-1146.

Bock, C. E., and J. H. Bock. 1991. Response of grasshoppers (Orthoptera: Acrididae) to wildfire in southeastern Arizona. The American Midland Naturalist 125:162-167.

Boerboom, C. 1993. Russian Thistle. Pacific Northwest Cooperative Extension Bulletin, Pacific Northwest Extention Publication.

Bowman, G. B., and L. D. Harris. 1980. Effects of spatial heterogeneity on ground-nest depredation. Journal of Wildlife Management 44:806-812.

Boyce, M. S. 1990. The red queen visits Sage grouse leks. American Zoology 30:263-270.

Boyd, C. S., D. Rollins, and D. M. Engle. 1997. Is good range management for livestock really good management for wildlife? Rangelands 19:19-21.

Braun, C. E. 1979. Evolution of the effects of changes in hunting regulations on sage grouse populations. Colorado Division of Wildlife, Game Research Report, Project W-37-R-32. Job 9a.

Braun, C. E. 1981. Vulnerability and population characteristics of sage grouse in Moffat County. Colorado Division of Wildlife, Final Report, Federal Aid Project W-37-R-34, Work Plan 3, Job 11.

Braun, C. E. 1986. Changes in sage grouse lek counts with advent of surface coal mining. Proceedings: Issues and Technology in the Management of Impacted Western Wildlife, Thorne Ecological Institute 2:227-231.

Braun, C. E. 1987. Current issues in sage grouse management. Proceedings of the Western Association of Fish and Wildlife Agencies 67:134-144.

Braun, C. E. 1995. Distribution and status of sage grouse in Colorado. Prairie Naturalist 27:1-9.

Braun, C. E. 1996. Drought. Proceedings of the sage grouse workshop Pinedale, Wyoming.

Braun, C. E. 1998. Sage grouse declines in western North America: what are the problems? Proceedings of the Western Association of State Fish and Wildlife Agencies 78:139-156.

Braun, C. E., K. M. Giesen, R. W. Hoffman, T. E. Remington, W. D. Snyder. 1994. Upland Bird Management Analysis Guide, 1994-1998. Colorado Division of Wildlife.

Braun, C. E., and T. D. Beck. 1985. Effects of changes in hunting regulations on sage grouse harvest and populations. Pages 335-343 in S.L. Beasom and S.F. Robertson, editors. Game Harvest Management. Caesar Kleberg Wildlife Research Institute, Kingsville, Texes, USA.

Braun, C. E., T. E. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildlife Society Bulletin 5:99-106.

Braun, C. E., M. F. Baker, R. L. Eng, J. S. Gashwiler, and M. H. Schroeder. 1976. Conservation committee report on the effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-171.

Briggs, S. A. 1992. Basic Guide to Pesticides: Their Characteristics and Hazards. Hemisphere Pub.

Briske, D. D., and J. W. Sluth. 1982. Tiller defoliation in a moderate and heavy grazing regime. Journal of Range Management 35:511-514.

Bromley, M. 1985. Wildlife management implications of petroleum exploration and development in wildland environments. United States Department of Agriculture, Forest Service, Intermountain Research Station General Technical Report INT-191. Ogden, Utah, USA.

Brown, J. K. 1982. Fuel and fire behavior predictions in big sagebrush. Research Paper INT-290. Ogden, Utah. USDA, Forest Service Intermountain Forest and Range Experimental Station.

Brown, J. K 2000. Ecological principles: Shifting fire regimes and management considerations. In Wildland fire in ecosystems: Effects of fire on flora. Eds. Brown, J. K. and Smith, J. K. Gen Tech. Rep. RMRS-GTR-42 vol. 2. Ogden, UT. USDA, For. Serv., Rocky Mt. Res. Stat. pp 185-203.

Brown, J. K 2000. Introduction and fire regimes. In Wildland fire in ecosystems: Effects of fire on flora. Eds. Brown, J. K. and Smith, J. K. Gen Tech. Rep. RMRS-GTR-42 vol. 2. Ogden, UT. USDA, For. Serv., Rocky Mt. Res. Stat. pp 1-7.

Brown, J. L. 1964. The evolution of diversity in avian territorial systems. Wilson Bulletin 76:160-169.

Bryant, L. D. 1982. Response of livestock to riparian zone exclusion. Journal of Range Management 35:780-785.

Bunting, S. C. 1989. Forest site preparation and range improvement. Pages 103-106 *in* D. M. Baumgartner, D. W. Breuer, B. A. Zamora, L. F. Neuenschwander, and R. H. Wakimoto. Proceedings: Prescribed fire in the intermountain region symposium.

Bunting, S. C., B. M. Kilgore, and C. L. Bushey. 1987. Guidelines for prescribed burning in sagebrush-grass rangelands in the northern Great Basin. United States Department of Agriculture. General Technical Report. INT-231. Forest Service Intermountain Research Station. Ogden, Utah, USA.

Burger, L. D., L. W. Burger, Jr., and J. Faaborg. 1994. Effects of prairie fragmentation on predation of artificial nests. Journal of Wildlife Management 58:249-254.

Burkhardt, J. W. and E. W. Tisdale 1976. Causes of juniper invasion in southwestern Idaho. Ecology 76: 472-484.

Burkhardt, J. W. 1995. Herbivory in the intermountain west: an overview of evolutionary history, historic cultural impacts and lessons from the past. Pacific Northwest Range Short Course. January 16-18. Boise, Idaho, USA.

Butler, R. B. 1978. Bison hunting in the desert west before 1800: the paleoecological potential and the archaeological reality. Plains Anthropologist 23:106-112.

Butler, M. D., and L. C. Burrill. 1994. Yellow toadflax and dalmation toadflax. Pacific Northwest Cooperative Extension Bulletin, Pacific Northwest Extention Publication.

Cade, T. J. 2000. Fires destroy grouse habitat. . Grouse Partnership News. North American Grouse Partnership. Winter 2000. pp10-11.

Carr, H. D. 1968. A literature review on effects of herbicides on sage grouse. Colorado Division of Game, Fish and Parks.

Castrale, J. S. 1982. Effects of two sagebrush control methods on nongame birds. Journal of Wildlife Management 46:945-952.

Castrale, J. S. 1987. Pesticide use in no-till fields relative to wildlife. Indiana Academy of Science 96:215-222.

Champlin, M. R. and A. H. Winward. 1982. The effect of simulated fire on emergence of seeds found in the soil of big sagebrush communities. Abstract of Papers. Society for Range Management. Calgary, Alberta. p. 37.

Chang, Chi-ru. 1996. Ecosystem responses to fire and variations in fire regimes. In: Sierra Nevada ecosystem project final report to Congress. Status of Sierra Nevada. Vol. II. Assessments and scientific basis for management options. Davis: Univ. CA. Wildland Resources: 1071-1100.

Charney, J., P. H. Stone, and W. J. Quirk. 1975. Drought in the Sahara: a biophysical feedback mechanism. Science 187:434-435.

Christensen, E. M. and H. B. Johnson. 1964. Presettlement vegetation and vegetational change in three valleys in central Utah. Brigham Young Univ. Sci. Bull. 4: 1-15.

Christianson, T. A., J. A. Lockwood and J. Powell. 1989. Arthropod community dynamics in undisturbed and intensively managed mountain brush habitats. Great Basin Naturalist 49:570-586.

Church, K. E. 1984. Nesting biology of gray partridge in east central Wisconsin. Pages 46-53 *in* R. T. Dumke, R. B. Stiehl, R. B. Kahl, editors. Proceedings of Perdix III: Grey Partridge and Ring-necked Pheasant Workshop, Wisconsin Department of Natural Resources.

Clifton, N. A. 1981. Response to prescribed fire in Wyoming big sagebrush\bluebunch wheatgrass habitat type. Thesis. University of Idaho, Moscow, Idaho, USA.

Coggins, K. A. 1998. Relationship between habitat changes and productivity of sage grouse at Hart Mountain National Antelope Refuge, OR. M.S. Thesis, ON State Univ. Corvallis, OR, USA.

Colenso-Postovit, B. 1981. Suggestions for sage grouse habitat reclamation on surface mines in Northeastern Wyoming. Thesis. University of Wyoming, Laramie, Wyoming, USA.

Connell, J. H. 1978. Diversity in tropical rain forests and coral reefs. Science 199:1302-1310.

Connelly, J. W. 1982. An ecological study of sage grouse in southeastern Idaho. Thesis. Washington State University, Pullman, Washington, USA.

Connelly, J. W. 1996. Pesticides. Proceedings of the sage grouse workshop Pinedale, Wyoming, USA.

Connelly, J. W., and C. E. Braun. 1997. Long-term changes in sage grouse (Centrocercus urophasianus) populations in western North America. Wildlife Biology 3:229-234.

Connelly, J. W., W. J. Arthur, and O. D. Markham. 1981. Sage grouse leks on recently disturbed sites. Journal of Range Management 52:153-154.

Connelly, J. W., Jr., H. W. Browers, and R. J. Gates. 1988. Seasonal movements of sage grouse in southeastern Idaho. Journal of Wildlife Management 52(1):116-122.

Connelly, J. W., K. P. Reese, R. A. Fischer, and W. L. Wakkinen. 2000a. Response of sage grouse breeding population to fire in southeastern Idaho. Wildlife Society Bulletin 28:90-95.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000b. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28:1-19.

Connelly, J. W., Jr., W. L. Wakkinen, A. D. Apa, and K. P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. Journal of Wildlife Management 55(3):521-524.

Connelly, J. W., W. L. Wakkinen, A. D. Apa, K. P. Reese, and J. W. Fischer. 1993. Re-nesting by sage grouse in southeastern Idaho. Condor 94:1041-1043.

Connelly, J. W., K. P. Reese, W. L. Wakkinen, M. D. Robertson, and J. W. Fischer. 1994. Sage grouse ecology report. Idaho Department of Fish and Game, Job Completion Report W-160-R-19 Subproject 9, Boise, Idaho, USA.

Conner, M. C., R. F. Labisky, and D. R. Progulske, Jr. 1983. Scent-station indices as measures of population abundance for bobcats, raccoons, gray foxes, and opossums. Wildlife Society Bulletin 11:146-152.

Conner, M. M., M. M. Jaeger, T. J. Weller, and D. R. McCullough. 1998. Effects of coyote removal on sheep depredation in northern California. Journal of Wildlife Management 62:690-699.

Cook, J. G., and L. L. Irwin. 1992. Climate-vegetation relationships between the Great Plains and the Great Basin. American Midland Naturalist 127(2):317-326.

Cote, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395-405.

Crabtree, R. L., L. S. Broome, and M. L. Wolfe. 1989. Effects of habitat characteristics on gadwall nest predation and nest-site selection. Journal of Wildlife Management 53:129-137.

Crawford, J. A. 1982. Factors affecting sage grouse harvest in Oregon. Wildlife Society Bulletin 10:374-377.

Crawford, J. A. 1996 Drought. Proceedings of the sage grouse workshop. Pinedale, Wyoming, USA

Crawford, J. A., M. A. Gregg, M. S. Drut, and A. K. DeLong. 1992. Habitat use by female sage grouse during the breeding season in Oregon. Final Report. Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA.

Crawford, J. A. 2000. Sage grouse and fire: A double-edged sword. Grouse Partnership News. N. Amer. Grouse Partnership. Winter 2000: p 9 and 11.

Cronquist, A., A.H. Holmgren, N. H. Holmgren, J.L. Reveal and P.K. Holmgren,. 1994. Intermountain flora: Vascular plants of the Intermountain West. USA. Asterales. Vol. 5. New York Botanical Garden, Bronx, New York.

Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1960. Seasonal movements and breeding behavior of sage grouse in Idaho. Transactions of North American Wildlife and Natural Resource Conference 25:396-407.

Dantzker, M. S., G. B. Deane, and J. W. Bradbury. 1999. Directional acoustic radiation in the strut display of male sage grouse Centrocercus urophasianus. The Journal of Environmental Biology 202:2893-2909.

Daubenmire. R. 1968. Ecology of fire in grasslands. Adv. Ecological Research 5: 209-266.

Daubenmire. R. 1970. Steppe vegetation of Washington. WA Agric. Exp. Sta. Tech. Bull. 62. WA State Univ., Pullman, WA.

Daubenmire. R. 1975. An analysis of structural and functional characters along a steppe-forest catena. Northwest Science 49: 120-140.

DeLong, A. K., J. A. Crawford, and D. C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial sage grouse nests. Journal of Wildlife. Management 59:88-92.

Derner, J. D., R. L. Gillen, F. T. McCollum, and K. W. Tate. 1994. Little bluestem tiller defoliation patterns under continuous and rotational grazing. Journal of Range Management 47:220-225.

Dibello, F. J., S. M. Arthur, and W. B. Krohn. 1990. Food habits of sympatric coyotes, Canis latrans, red foxes, Vulpes vulpes, and bobcats, Lynx rufus, in Maine. The Canadian Field Naturalist 104:403-408.

Diefenbach, D. R., M. J. Conroy, R. J. Warren, W. E. James, L. A. Baker, and T. Hon. 1994. A test of the scent-station survey technique for bobcats. Journal of Wildlife Management 58:10-17.

Dobkin, D. S., A. C. Rich, and W. H. Pyle. 1998. Habitat and avifaunal recovery from livestock grazing in a riparian meadow system of the northwest Great Basin. Conservation Biology 12:209-221.

Doerr, T. B. and F. S. Guthery. 1983. Effects of Tebuthiuron on lesser prairie-chicken habitat and foods. Journal of Wildlife Management 47:1138-1142.

Drut, M. S., J. A. Crawford, and M. A. Gregg. 1994. Brood habitat use by sage grouse in Oregon. Great Basin Naturalist 54:170-176.

Duebbert, H. F., and H. A. Kantrud. 1974. Upland duck nesting related to land use and predator reduction. Journal of Wildlife Management 38:257-265.

Dunn, E. 1977. Predation by weasels (Mustela nivalis) on breeding tits (Parus spp.) in relation to the density of tits and rodents. Journal of Animal Ecology 46:633-652.

Dunn, P. O., and C. E. Braun. 1986. Summer habitat use by female and juvenile sage grouse. Journal of Wildlife Management 50:228-235.

EOARC . Eastern Oregon Agricultural Res. Center. OR State Univ., Burns, OR. data files.

Eddleman, L. E. and P. S. Doescher. 1999. Current issues in the sagebrush steppe ecosystem: grazing, fire, and other disturbances. Pages21-23 *in* P. G. Entwistle, A. M. DeBolt, J. H. Kaltenecker, and K. Steenhof, compilers. Proceedings: Sagebrush Steppe Ecosystems Symposium. Bureau of Land Management Publication Number BLM/ID/PT-001001=1150, Boise, Idaho, USA.

Eckert, R. E. Jr., and J. S. Spender. 1987. Growth and reproduction of grasses heavily grazed under rest-rotation management. Journal of Range Management 40: 156-159.

Eddleman, L. E. and P. S. Doescher. 1999. Current issues in the sagebrush steppe ecosystem: grazing, fire, and other disturbances. Pages 21-23 *in* P. G. Entwistle, A. M. DeBolt, J. H. Kaltenecker, and K. Steenhof, compilers. Proceedings: Sagebrush Steppe Ecosystems Symposium. Bureau of Land Management Publication Number BLM/ID/PT-001001=1150, Boise, Idaho, USA.

Ellis, K. L. 1985. Effects of a new transmission line on distribution and aerial predation of breeding male sage grouse. United States Bureau of Land Management, Final Report IV-H-10.

Ellison, L. N. 1991. Shooting and compensatory mortality in tetraonids. Ornis Scandinavica 22:229-240.

Emmerich, F. L., F. H. Tipton, and J. A. Young. 1993. Cheatgrass: changing perspectives and management strategies. Rangelands 15:37-40.

Enck, J. W. 1987. The effect of insect abundance on gray partridge chick survivorship in New York. Pages 3-16 *in* R. O. Kimmel, J. W. Schulz, and G. J. Mitchell, editors. Proceedings of Perdix IV: Grey Partridge and Ring-necked Pheasant Workshop. Minnesota Department of Natural Resources, Farmland Wildlife Populations and Research Group.

Eng, R.L. 1952. A two summer study of the effects on bird populations of chlordane bait and aldrin spray as used for grasshopper control. Journal of Wildlife Management 16:326-337

Eng, R. L. 1963. Observations on the breeding biology of male sage grouse. Journal of Wildlife Management 27:841-846.

Eng, R. L., and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. Journal of Wildlife Management 36:141-146.

Enyeart, G. 1956. Responses of sage grouse to grass reseeding in the Pines area, Garfield County, UT. Thesis, UT State Agriculture College, Logan, Utah, USA.

Evans, C. C. 1986. The relationship of cattle grazing to sage grouse use of meadow habitat on the Sheldon National Wildlife Refuge. Thesis. University of Nevada, Reno, Nevada, USA.

Extoxnet: Extension Toxicology Network, Pesticide Information Profiles. A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. Supported by USDA/Extension Service/National Agricultural Pesticide Impact Assessment Program. http://ace.orst.edu/info/extoxnet/faqs/

Ferguson, G. 1996. The Yellowstone wolves, the first year. Falcon Press. Helena, Montana, USA.

Fischer, R. A. 1994. The effects of prescribed fire on the ecology of migratory sage grouse in southeastern Idaho. Thesis, University of Idaho, Moscow, Idaho, USA.

Fischer, R. A., K. P. Reese, and J. W. Connelly. 1996. An investigation on fire effects within xeric sage grouse brood habitat. Journal of Range Management 49:194-198.

Fischer, R. A., W. L. Wakkinen, K. P. Reese, and J. W. Connelly. 1997. Effects of prescribed fire on movement of female sage grouse from breeding to summer ranges. Wilson Bulletin 109(1):82-91.

Forman, R. T. T., and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecological Systems 29:207-231.

Forsyth, D. J., and N. D. Westcott. 1994. Carbofuran residues in grasshoppers and vegetation from aerially sprayed prairie pastures: potential effects on wildlife. Environmental Toxicology and Chemistry 13:299-306.

Fosberg, M. A.and M. Hironaka. 1964. Soil properties affecting the distribution of big and low sagebrush communities in southern Idaho. In: Forage plant physiology and soil-range relationships. ASA Spec. Publ. No. 5. p. 230-236.

Frandsen, W. H. 1983. Modeling big sagebrush as a fuel. Journal of Range Management 36:596-600.

Franson, J. C., E. J. Kolbe, and J. W. Carpenter. 1985. Famphur toxicosis in a bald eagle. Journal of Wildlife Diseases 21:318-320.

Freeburn, J. W. 1979. An economic analysis of sagebrush spraying in Wyoming. M.S. Thesis. Univ. WY, Laramie, WY.

Gates, R. J. 1983. Sage grouse, lagomorph, and pronghorn use of a sagebrush grassland burn site on the Idaho National Engineering Laboratory. Thesis. Montana State University, Bozeman, Montana, USA.

Gates, R. J. 1985. Observations of the formation of a sage grouse lek. Wilson Bulletin 97:219-221.

George, T. L., L. C. McEwen, and A. Fowler. 1992. Effects of a carbaryl bait treatment on nontarget wildlife. Environmental Entomology 21:2139-1247.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1989. Population dynamics of coyotes in southeastern Colorado. Journal of Wildlife Management 53:174-181.

Gibson, R. M. 1989. Field playback of male display attracts females in lek breeding sage grouse. Behavioral Ecology and Sociobiology 24:439-443.

Gibson, R. M. 1990. Relationships between blood parasites, mating success and phenotypic cues in male sage grouse Centrocercus urophasianus. American Zoologist 30:271-278.

Gibson, R. M. and J. W. Bradbury. 1985. Sexual selection in lekking sage grouse: phenotypic correlates of male mating success. Behavioral Ecology and Sociobiology 18:177-123.

Giesen, K. M. 1994. Evaluation of livestock grazing and residual herbaceous cover on sage grouse nest success. Colorado Division of Wildlife, Upland Bird Research 18:W-167-R.

Gill, R. B. 1965. Distribution and abundance of a population of sage grouse in North Park, Colorado. Thesis, Colorado State University, Fort Collins, Colorado, USA.

Girard, G. L. 1937. Life history, habits, and food of the sage grouse Centrocercus urophasianus Bonaparte. University of Wyoming Publication 3., Laramie, Wyoming, USA.

Goodrich, S., D. Nelson, and N. Gale. 1998. Some features of Wyoming big sagebrush communities on gravel pediments of the Green River in Daggett County, Utah. Unpublished Report.

Goodrich, S., D. Nelson, and N. Gale. 1999. Some features of Wyoming big sagebrush communities on gravel pediments of the Green River Daggett County, UT. In: D. E. McArthur, W. K. Ostler, D. L. Wambolt (comps.), Shrubland Ecotones. USDA For. Ser. Proc. RMRS-P-11. pp 159-167.

Grayson, D. K. 1993. The desert's past: a natural prehistory of the Great Basin. Smithsonian Institution Press. Washington D. C., USA.

Greenwood, R. J., A. B. Seargent, J. L. Pielhl, D. A. Buhl, and B. A. Anderson. 1999. Foods and foraging of prairie striped skunks during the avian nesting season. Wildlife Society Bulletin 27:823-832.

Gregg, M. A. 1991. Use and selection of nesting habitat by sage grouse in Oregon. Thesis, Oregon State University, Corvallis, Oregon, USA.

Gregg, M. A. 2001. Sage grouse reproductive ecology and habitat associations: Applications to management. In Ecology and management of sage grouse: Expanded abstracts. 54th Ann. Meeting of SRM, Kona HI, USA. pp 8-12.

Gregg, M. A., J. A. Crawford, M. S. Drut, and A. K. DeLong. 1994. Vegetational cover and predation sage grouse nests in Oregon. Journal of Wildlife Management 58(1):162-166.

Grime, J. P. 1973. Control of species density in herbaceous vegetation. Journal of Environmental Management 1:151-167.

Gruell, G. E. 1985. Fire on the early western landscape: An annotated record of wildland fires 1771-1900. Northwest Sci. 59: 97-107.

Gruell, G. E. 1999. Historical and modern roles of fire in pinyon-juniper. In: S. B. Monson and R. Stevens (Comps)., Proceeding : Ecology and management of pinyon-juniper communities within the interior West. 1997. Provo, UT. USDA For. Ser. Proc. RMRS-P-9. Ogden, UT pp 24-28.

Gruell, G. E., L.E. Eddleman and R. Jandl. 1994. Fire history of the pinyon-juniper woodlands of Great Basin National Park. USDI, National Park Serv. Tech. Rep. NPS/PNROSU/NRTR-94-01.

Gutherie, R. D. 1990. Frozen fauna of the mammoth steppe. University of Chicago Press. Chicago, Illinois, USA.

Hall, F. C., and L. Bryant. 1995. Herbacious stubble height as a warning of impending cattle grazing damage to riparian areas. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-362. Portland, Oregon, USA.

Halley, B. A., W. J. A. VandenHeuvel, and P. G. Wislocki. 1993. Environmental effects of the usage of avermectins in livestock. Veterinary Parasitology 48:109-125.

Hanson, W. R. and L. A. Stoddart. 1940. Effects of grazing upon bunch wheat grass. Am. Soc. Agron. 32: 278-289.

Harniss, R. O. and R. B. Murray. 1973. 30 years of vegetal change following burning of sagebrush-grass range. Journal of Range Management 26:322-325.

Harniss, R. O., and H. A. Wright. 1982. Summer grazing of sagebrush-grass range by sheep. Journal of Range Management 35:13-17.

Hart, R. H., and E. F. Balla. 1982. Forage production and removal from western and crested wheatgrass under grazing. Journal of Range Management 35:362-366.

Hart, R. H., S. Clapp, and P. S. Test. 1993. Grazing strategies, stocking rates, and frequency and intensity of grazing on western wheatgrass and blue grama. Journal of Range Management 46:122-126.

Hart, R. H., M. J. Samual, P. S. Test, and M. A. Smith. 1988. Cattle, vegetation, and economic responses to grazing systems and grazing pressure. Journal of Range Management 41:282-286.

Hart, R. H., M. J. Samuel, J. W. Waggoner, Jr., and M.A. Smith. 1989. Comparisons of grazing systems in Wyoming. Journal of Soil and Water Conservation 44:344-347.

Hart, R. H., K. W. Hepworth, M. A. Smith, and J. W. Waggoner, Jr. 1991a. Cattle grazing behavior on a foothill elk winter range in southeastern Wyoming. Journal of Range Management 44:262-265.

Hart, R. H., M. J. Samuel, J. W. Waggoner, Jr., and M. A. Smith. 1991b. Grazing systems in Wyoming—Impacts of grazing pressure and livestock distribution. Rangelands 13:12-16.

Hassan, M. A. and West, N. E. 1986. Dynamics of soil seed pools in burned and unburned sagebrush semi-deserts. Ecology. 67(1): 269-272.

Hayden-Wing, L.D., D.B. Costain, J.L. Hull, M.R. Jackson and T.B. Segerstrom. 1986. Movement patterns and habitat affinities of a sage grouse population in northeastern Wyoming. Proceedings, Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute 2:207-226.

Heath, B., R. Straw, S. Anderson, and J. Lawson. 1996. Proceedings of sage grouse workshop. Pinedale, Wyoming, USA.

Heath, B., R. Straw, S. Anderson, and J. Lawson. 1997. Sage grouse productivity, survival, and seasonal habitat use near Farson, Wyoming. Wyoming Game and Fish Department, Completion Report. Cheyenne, Wyoming, USA.

Heath, B., R. Straw, S. Anderson, J. Lawson, and M. Holloran. 1998. Sage-grouse productivity, survival, and seasonal habitat use among three ranches with different livestock grazing, predator control, and harvest management practices. Wyoming Game and Fish Department Completion Report. Cheyenne, Wyoming, USA.

Heitschmidt, R. K., J.R Conner, S. K. Cannon, W. E Pinchak, J. W. Walker, and S. L. Dowhower. 1990. Cow/calf production and economic returns from yearlong continuous, deferred rotation and rotational grazing treatments. Journal of Agriculture Production 3:92-99.

Hepworth, K. W., P. S. Test , R. H. Hart., J. W. Waggoneer, Jr., and M.A. Smith. 1991. Grazing systems, stocking rates, and cattle behavior in southeastern Wyoming. Journal of Range Management 44:259-262.

Henny, C. J., L. J. Blus, E. J. Kolbe, and R. E. Fitzner. 1985. Organophosphate insecticide (Famphur) topically applied to cattle kills magpies and hawks. Journal of Wildlife Management 49:648-658.

Herman, C. M. 1963. Disease and infection in the Tetraonidae. Journal of Wildlife Management 27:850-855.

Hickey, J. J. 1955. Some American population research on gallinaceous birds. Pages 326-396 *in* A. Wolfson, editor. Recent studies in avian biology. University of Illinois Press, Urbana, Illinois, USA.

Higby, W. 1964. Spraying effects on wildlife. WY Wildlife Vol. XXVIII, No. 12 Wyoming Game and Fish Dept. Cheyenne, WY p4-7.

Higby, W. 1965. Effects of sagebrush spraying on sage grouse populations. In: Western States Sage Grouse Workshop. Paper.

Higby, W. 1969. A summary of the Longs Creek control project. Proc. Biennial Western State Sage Grouse Workshop 6: 164-168.

Hill, E. F. and V. M. Mendenhall. 1980. Secondary poisoning of barn owls with famphur, an organophosphate insecticide. Journal of Wildlife Management 44:676-681.

Hoffman, R. W. 1985. Effects of changes in hunting regulations on blue grouse populations. Pages 327-334 *in* S. L. Beason and S .F. Robertson, editors. Game Harvest Management. Caesar Kleburg Wildlife Resource Institute, Kingsville, Texas, USA.

Hoglund, J., R. V. Alatalo, and A. Lundberg. 1992. The effects of parasites on male ornaments and female choice in the lek-breeding black grouse (Tetrao tetrix). Behavioral Ecology and Sociobiology 30:71-76.

Holechek, J. L. 1996. Drought in New Mexico: prospects and management. Rangelands 18:225-227.

Holechek, J. L. and Stephenson, T. 1983. Comparison of big sagebrush vegetation in north-central New Mexico under moderately grazed and grazing excluded conditions. Journal of Range Management 36: 455-456.

Holger, J. P., D. Rollins, and R. L. Gillen. 1990. Effects of cattle stock density on trampling loss of simulated ground nests. Wildlife Society Bulletin 18:71-74.

Holloran, M. J. 1999. Sage grouse (*Centrocercus urophasianus*) seasonal habitat use near Casper, Wyoming. Thesis, University of Wyoming, Laramie, Wyoming, USA.

Homer, C. G., T. C. Edwards, Jr., R. D. Ramsey, and K. P. Reese. 1993. Use of remote sensing methods in modeling sage grouse winter habitat. Journal of Wildlife Management 57(1):78-84.

Honess, R. F. and G. Post. 1968. History of an epozootic in Sage grouse. University of Wyoming Agricultural Experiment Station Scientific Monographs. 14:1-33.

Houston, D. B. 1973. Wildfires in northern Yellowstone National Park. Ecology 54: 1109-1117.

Hudson, R. H. R. K. Tucker, M.A. Haegele. 1984. Handbook of Toxicity of Pesticides to Wildlife. United States Department of the Interior Fish and Wildlife Service.

Hull-Sieg, C., D. W. Uresk, and R. M. Hanson. 1987. Impact of bentonite mining on selected arthropods. Journal of Range Management 40:128-131.

Hupp, J. W., and C. E. Braun. 1989. Topographic distribution of sage grouse foraging in winter. Journal of Wildlife Management 53(3):823-829.

Jensen, M.E. and R. Evertt. 1994. An overview of ecosystem management principles. In: Eastside forest ecosystem health assessment: Volume II: Ecosystem Management: Principles and applications. M.E. Jensen and PIS. Bourgerom (eds.). USDA, For. Serv. Gen. Tech. Rep. PNW-GTR-318. p6-13.

Johnson, W. M. 1969. Life expectancy of a sagebrush control in central Wyoming. Journal of Range Management 22:177-182.

Johnson, G. D., and M. S. Boyce. 1990. Feeding trials with insects in the diet of sage grouse chicks. Journal of Wildlife Management 54(1):89-91.

Johnson, K. H. and C. E. Braun. 1999. Viability and conservation of an exploited sage grouse population. Conservation Biology 13:77-83.

Johnson, K. H., R. A. Olson, and T. D. Whitson. 1996. Composition and diversity of plant and small mammal communities in Tebuthiuron-treated big sagebrush (Artemisia tridentata). Weed Technology 10:404-415.

Johnson, M. K. and R. M. Hansen. 1979. Coyote food habits on the Idaho National Engineering Laboratory. Journal of Wildlife Management 43:951-956.

Johnson, T. N., Jr., and H. L. Morton. 1989. Tebuthiuron persistence and distribution in some semiarid soils. Journal of Environmental Quality 18:433-438.

Johnson, T. N., Jr., and H. L. Morton. 1991. Long-term tebuthion content of grasses and shrubs on semiarid rangelands. Journal of Range Management 44:249-253.

Johnson, W. M. 1958. Reinvasion of big sagebrush following chemical control. Journal of Range Management 11:169-172.

Johnston, J. J., ed. 2001. Pesticides and Wildlife. (ACS symposium series; 771) American Chemical Society, 2001.

Kearl, W. G. and J. W. Freeburn. 1980. Economics of big sagebrush control for mitigating reductions of federal grazing permits. University of Wyoming Division of Agricultural Economics AE 80-05R.

Kindschy, R.R. 1991. Pristine vegetation of the Jordan Crater Kipukas: 1978-91. USDI, BLM, Vale, OR.

Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. Journal of Wildlife Management 33:649-662.

Klebenow, D. A. 1970. Sage grouse vs. sagebrush control in Idaho. Journal of Range Management 23:396-400.

Klebenow, D. A. 1972. The habitat requirements of sage grouse and the role of fire in management. Tall Timbers Fire Ecology Conference 12:305-315.

Klebenow, D. A. 1982. Livestock grazing interactions with sage grouse. Pages 113-123 *in* J. M. Peck and P. D. Dalke, editors. Wildlife-Livestock Relationships Symposium: Proceedings 10, Coeur d'Alene, Idaho, USA.

Klebenow, D. A. 1985. Habitat management for sage grouse in Nevada. World Pheasant Association 10:34-46.

Klebenow, D. A., and G. M. Gray. 1968. Food habits of juvenile sage grouse. Journal of Range Management 21:80-83.

Klebenow D., G. Zunino, M. Stigar, and A. Alstatt. 1990. Sage grouse production and mortality studies. Nevada Department of Wildlife, Job Final Report, Federal Aid Project W-48-R-21, Study XVII, Job 1.

Klott, J. H., and F. G. Lindzey. 1990. Brood habitats of sympatric sage grouse and Columbian sharp-tailed grouse in Wyoming. Journal of Wildlife Management 54(1):84-88.

Knight, D.H. 1994. Mountains and Plains: Ecology of Wyoming Landscapes. Yale University. 338p.

Kobriger, G. 1980. Food habitats of Hungarian partridge in North Dakota. North Dakota Game and Fish Department.

Koerth, B. H., W. M. Webb, F. C. Bryant, and F. S. Guthery. 1983. Cattle trampling of simulated ground nests under short duration and continuous grazing. Journal of Range Management 36:385-386.

Kolb, K. J., and J. S. Sperry. 1999. Differences in drought adaption between subspecies of sagebrush (Artemisia tridentata). Ecology 80(7):2373-2384.

Krementz, D. G., and J. R. Sauer. 1982. Avian communities on partially reclaimed mine spoils in south central Wyoming. Journal of Wildlife Management 46:761-765.

Kuchler, A. W. 1985. Potential natural vegetation (map at scale of 1:7,500,000). In: USGS, The National Atlas of the USA. U.S. Govt. Print. Off., Washington, D.C.

Kurtin, B., and E. Anderson. 1980. Pleistocene mammals of North America. Columbia University Press. New York, New York, USA.

Kurtz, G. L. 1995. Ecological inplications of Russian knapweed (Centaurea repens L.) infestation:small mammal and habitat associations. Thesis, Department of Rangeland Ecology and Watershed Management, University of Wyoming, Laramie, Wyoming, USA.

Laycock W. A. 1979a. How heavy grazing and protection affect sagebrush-grass ranges. Intermountain Forest and Range Experiment Station, Forest Service, United States Department of Agriculture, Logan, Utah, USA.

Laycock, W. A. 1979b. Management of Sagebrush. Rangelands 1:207-210.

Lindstrom, E., P. Angelstam, P. Widen, and H. Andren. 1986. Do predators synchronize vole and grouse fluctuations? – An experiment. Oikos 48:121-124.

Lumaret, J. P, E. Galante, C. Lumbreras, J. Mena, M. Bertrand, J. L. Bernal, J. F. Cooper, N. Kadiri, and D. Crowe. 1993. Field effects of ivermectin residues on dung beetles. Journal of Applied Ecology 30:428-436.

Lyon, A. G. 2000. The potential effects of natural gas development on sage grouse (*Centrocercus urophasianus*) near Pinedale, Wyoming. Thesis, University of Wyoming, Laramie, Wyoming, USA.

Mack, R. N., and J. N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. American Naturalist 119:757-773.

Mahrt, J. L., F. C. Zwinkel, and T. G. Tessier. 1991. Blood parasites of blue grouse (Dendragapus obscurus) in western North America. Journal of Wildlife Disease 27:482-485.

Major, J. T. and J. A. Sherburne. 1987. Interspecific relationships of coyotes, bobcats, and red foxes in western Maine. Journal of Wildlife Management 51:606-616.

Mankin, P. L., and R. E. Warner. 1992. Vulnerability of ground nests to predation on an agricultural habitat island in east-central Illinois. American Midland Naturalist 128(2):281-291.

Manley, W. A., R. H. Hart, M. J. Samuel, M. A. Smith, J. W. Waggoner, Jr., and J. T. Manley. 1997. Vegetation, cattle, and economic responses to grazing strategies and pressures. Journal of Range Management 50:638-646.

Marcstrom, V., R. E. Kenward, and E. Engren. 1988. The impact of predation on boreal tetraonids during vole cycles: an experimental study. Journal of Animal Ecology 57:859-872.

Martin, N. S. 1970. Sagebrush control related to habitat and sage grouse occurrence. Journal of Wildlife Management 34:313-320.

Martin, R. C. 1990. Sage grouse responses to wildfires in spring and summer habitats. Thesis. University of Idaho, Moscow, Idaho, USA.

McAdoo, J. K., and D. A. Klebenow. 1978. Predation on range sheep with no predator control. Journal of Range Management 31:111-114.

McArthur, D.E., A. C. Blauer, and S.C. Sanderson. 1988. Mule deer induced mortality of big sagebrush. Journal of Range Management 41: 114-117.

McCracken, D. I. 1993. The potential for avermectins to affect wildlife. Veterinary Parasitology 48:273-280.

McDowell, M.K.D. 2000. The effects of burning in mountain big sagebrush on key sage grouse habitat characteristics in southeastern Oregon. M.S. Thesis Oregon State University, Corvallis, OR.

McKell, C. M. 1975. Shrubs-a neglected resource. Science 187:803-809.

McNown, C. D., Walker J. W., J. W. Stuth, and R. K. Heitschmidt. 1991. Nutrient intake of cattle on rotational and continuous grazing treatments. Journal of Range Management 44:596-601.

Mead, J. I., L. D. Agenbroad, O. K. Davis, and P. S. Martin. 1986. Dung of *Mammuthus* in the arid southwest, North America. Quaternary Research 25:121-127.

Messick, J. P., E. G. Bizeau, W. W. Benson, and W. H. Mullins. 1974. Aerial pesticide applications and ring-necked pheasants. Journal of Wildlife Management 38:679-685.

Milchunas, D. G., and W. K. Lauenroth. 1993. Quantitative effects of grazing on vegetation and soils over a global range of environments. Ecological Monographs 63:327-366.

Miller, M. 2000. Fire autoecology. In Wildland fire in ecosystems: Effects of fire on flora. Eds. Brown, J. K. and Smith, J. K. Gen Tech. Rep. RMRS-GTR-42 vol. 2. Ogden, UT. USDA, For. Serv. Rocky Mt. Res. Stat. pp 9-34.

Miller, R. 2001. The role of fire in sage grouse habitat. In: Ecology and management of sage grouse: Expanded Abstracts. 54th Annual Meeting of SRM, Kona, HI. PP 13-19.

Miller, R. G., Findley, R. R. and Alderfer-Findley, J. 1980. Changes in mountain big sagebrush habitat types following spray release. Journal of Range Management 33: 278-281.

Miller, R. F., T. J. Svejcar, and N. E. West. 1994. Implications of livestock grazing in the intermountain sagebrush region: plant composition. Pages 101-146 *in* M. Vavra, W. A. Laycock, and R. D.

Pieper, editors. Ecological Implications of livestock herbivory in the west. Society for Range Management, Denver, Colorado, USA.

Miller, R. F., T. J. Svejcar, and J.A. Rose. 2000. Western juniper succession in shrub steppe: Impacts on community composition and structure. Journal of Range Management.

Miller, R. F., and J. A. Rose. 1995. Western juniper expansion in eastern Oregon. Great Basin Naturalist 55: 37-45.

Miller, R. F., and J. A. Rose. 1998. History, ecology and management of western juniper woodlands and associated shrublands: An annual report of preliminary results and progress. Eastern Oregon Agric. Reseach Center, OR State Univ. and USDA Agric. Research Serv. Burns, OR.

Miller, R. F., and J. A. Rose. 1999. Western juniper expansion in eastern Oregon. Great Basin Naturalist 55: 37-45.

Miller, R. F., and P.E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands: Response to climate, fire and human activities in the U. S. Great Basin. BioScience 44: 465-474.

Miller, R. F., and L. L. Eddleman. 2000. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State Agricultural Experiment Station Technical Bulletin 151. 35p.

Moorman, T., and F. B. Reeves. 1979. The role of endomycorrhizae in revegetation practices in the simi-arid west. II. A bioassay to determine the effect of land disturbance on endomycorrhizal populations. American Journal of Botany 66:14-18.

Morton, D. M. and D. G. Hoffman. 1976. Metabolism of a new herbicide, tebuthiuron {1-[5-(1,1-Dimethylenthyl)-1,3,4-Thiadiazol-2-YL]-1,3-dimethylurea}, in mouse, rat, rabbit, dog, duck, and fish. Journal of Toxicology and Environmental Health 1:757-768.

Mueggler, W. F. 1950. Effects of spring and fall grazing by sheep on vegetation of the upper snake river plains. Journal of Range Management 3:308-315.

Mueggler, W. F., and J. P. Blaisdell. 1958. Effects on associated species of burning, rotobeating, spraying, and railing sagebrush. Journal of Range Management 11:61-66.

Mulholland, J.L. 1984. Big sagebrush response and reestablishment following chemical control in western Wyoming. M.S. Thesis. Univ. WY, Laramie, WY.

Murie, J. O. 1992. Predation by badgers on Columbian ground squirrels. Journal of Mammalogy 73:385-394.

National Academy of Science. 1994. Rangeland Health.

Neel, L. A. 1980. Sage grouse response to grazing management in Nevada. Thesis, University of Nevada, Reno, Nevada, USA.

Nelle, P. J. 1998. The long-term effects of fire on sage grouse nesting and brood –rearing habitats on the Upper Snake River Plain. Thesis. University of Idaho, Moscow, Idaho, USA.

Nelle, P. J., K. P. Reese, and J. W. Connelly. 2000. Long-term effect of fire on sage grouse nesting and brood-rearing habitats in the Upper Snake River Plain. Journal of Range Management 53-586-591.

Niemuth, N. D. 1992. Effects of nest predation on breeding biology of sage grouse (Centrocercus urophasianus). Thesis, University of Wyoming, Laramie, Wyoming, USA.

Norelius, E. E., and J. A. Lockwood. 1999. The effects of reduced agent-area insecticide treatment for rangeland grasshopper (Orthoptera:Acrididae) control on bird densities. Archives of Environmental Contamination and Toxicology 37:519-528.

Oakleaf, R. J. 1971. The relationship of sage grouse to upland meadows in Nevada. Nevada Department of Fish and Game, Job Final Report, Federal Aid Project W-48-2.

Olson K. C., G. B. Rouse, and J. C. Malechek. 1989. Cattle nutrition and grazing behavior during short-duration-grazing periods on crested wheatgrass range. Journal of Range Management 42:153-157.

Olson, R., J. Hanson, T. Whitson, and K. Johnson. 1994. Tebuthiuron to enhance rangeland diversity. Rangelands 16:197-201.

Olson, R. A. and T. D. Whitson. 1999. Enhancing rangeland productivity and biodiversity by thinning big sagebrush with tebuthiuron. Abstract, 52: 57th SRM meeting, Omaha, NE.

Omphile, U. 1986. Vegetation and soil moisture responses following three big sagebrush control methods. Thesis. University of Wyoming, Laramie, Wyoming, USA.

Overbay, J. C. 1992. Ecosystem management. In: Procceding of the national workshop: taking an ecological approach to management. 1992 April; Salt Lake City, UT.USDA, For. Serv. WO-WSA-3, Wahington, D.C. p 3-15.

Owens, M. K., and B. E. Norton. 1990. Survival of juvenile basin big sagebrush under different grazing regimes. Journal of Range Management 43:132-135.

Owens, M. K., and B. E. Norton. 1992. Interactions of grazing and plant protection on basin big sagebrush (Artemisia tridentata spp. tridentata) seedling survival. Journal of Range Management 45:257-251.

Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, Idaho, USA.

Paine, L., D. J. Undersander, D. W. Sample, G. A. Bartelt, and T. A. Schatteman. 1996. Cattle trampling of simulated ground nests in rotationally grazed pastures. Journal of Range Management 49:294-299.

Parmenter, R. R., J. A. MacMahon. 1987. Early successional patterns of arthropod recolonization on reclaimed strip mines in southwestern Wyoming: The ground dwelling beetle fauna (Coleoptera). Environmental Entomology 16:168-175.

Passey, H.B., Hugie, V.K., Williams, E. W., and Ball, D.E. 1982. Relationships between soil, plant community, and climate on rangelands of the Intermountain West, U. S. USDA, Tech. Bull No. 1669. 118p.

Patterson, R. L. 1952. The sage grouse in Wyoming. Sage Books Incorporated, Denver, Colorado, USA.

Paysen, T. E., Ansley, J. R., Brown, J. K., Gottfried, G. J., Hasse, S. M., Harrington, M. G., Narog, M. G., Sackett, S. S., and Wilson, R. C. 2000. Fire in western shrubland, woodland and grassland ecosystems. In: Wildland fire in ecosystems: Effects of fire on flora. Eds. Brown, J. K. and Smith, J. K. Gen Tech. Rep. RMRS-GTR-42 vol. 2. Ogden, UT. USDA, For. Serv,, Rocky Mt. Res. Stat. pp 121-159.

Pearson, L. C. 1965. Primary production in grazed and ungrazed desert communities of eastern Idaho. Ecology. 46: 278-285.

Pechanec, J.F., A. P. Plummer, J. H. Robertson, and A. C. Hull. 1965. Sagebrush control on rangelands. USDA, Handbook No. 277.

Peterson, J. G. 1970. The food habits and summer distribution of juvenile sage grouse in central Montana. Journal of Wildlife Management 34:147-155.

Peterson, J. G. 1995. Ecological implications of sagebrush manipulations. Montana Fish, Wildlife, and Parks, Wildlife Management Division, Federal Aid Project W-101-R-2.

Phillips, R. L., D. E. Biggins and A. B. Hoag. 1986. Coal surface mining and selected wildlife-a ten year study near Decker, Montana. Proceedings, Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute 2:235-244.

PIC Technologies Inc. 1999. Draft Environmental Impact Statement for the Pinedale anticline natural gas field exploration and development project, Sublette, Wyoming. United States Department of the Interior Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming.

Pierson, F. B., and D. L. Scarnecchia. 1987. Defoliation of intermediate wheatgrass under seasonal and short-duration grazing. Journal of Range Management 40:228-232.

Pieper, R. 1994. Ecological implications of livestock grazing. Pages 177-211 *in* M. Vavra, W. A. Laycock, and R. D. Pieper, editors. Ecological Implications of livestock herbivory in the west. Society for Range Management, Denver, Colorado, USA.

Pinchak, W. E., M. A. Smith, R. H. Hart, and J. W. Waggoner, Jr. 1991. Beef cattle distribution patterns on foothill range. Journal of Range Management 44:267-275.

Pitts, J. S., and F. C. Bryant. 1987. Steer and vegetation response to short duration grazing. Journal of Range Management 40:386-389.

Post, G. 1951. Effects of toxephene and chlordane on certain game birds. Journal of Wildlife Management 15:381-386.

Powell, G. V. and D. C. Gray. 1980. Dosing free-living nestling starlings with an organophosphate pesticide, famphur. Journal of Wildlife Management 44:918-921.

PRISM Environmental Management Consultants. 1982. A review of petroleum industry operations and other land use activities affecting wildlife. The Canadian Petroleum Association. Calgary, Alberta. 20pp.

Pyle, W. H. and J. A. Crawford. 1996. Availability of foods of sage grouse chicks following prescribed fire in sagebrush-bitterbrush. Journal of Range Management 49:320-324.

Pyrah, D. B. 1970. Sage grouse habitat research in central Montana. In E. F. Schlatterer and D.B. Pyrah, editors. Ecological effects of chemical and mechanical sagebrush control. Montana Fish and Game Department Completion Report, Project W-105-R-4:293-300.

Rasmussen, D. I., and L. A. Griner. 1938. Life history and management studies of the sage grouse in Utah, with special reference to nesting and feeding habits. Transactions of the North American Wildlife Conference 3:852-864.

Rauchfuss, F. L. 1955. The ecology of Halogeton glomeratus on Wyoming rangelands. Thesis. University of Wyoming, Laramie, Wyoming, USA.

Rees, E. 1993. Threatened, endangered, and sensitive species affected by livestock production: a preliminary survey of data available in ten western states. Unpublished Data, Audubon Society of Portland, Oregon, USA.

Reeves, F. B., D. Wagner, T. Moorman, and J. Kiel. 1979. The role of endomycorrhizae in revegetation practices in the simi-arid west. I. A comparison of incidence of mycorrhizae in severely disturbed vs. natural environments. American Journal of Botany 66:6-13.

Reichel, J. D. 1991. Relationships among coyote food habits, prey populations, and habitat use. Northwest Science 65(3):133-137.

Remington, T. E., and C. E. Braun. 1985. Sage grouse food selection in winter, North Park, Colorado. Journal of Wildlife Management 49:1055-1061.

Remington, T. E. and C. E. Braun. 1991. How surface coal mining affects sage grouse, North Park, Colorado. Proceedings, Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute 5:128-132.

Reynolds, R. T., and C. H. Trost. 1980. The response of native vertebrate populations to crested wheatgrass planting and grazing by sheep. Journal of Range Management 33:122-125.

Rickard, W. H. 1970. Ground dwelling beetles in burned and unburned vegetation. Journal of Range Management 23:293-294.

Rickard, W. H. and Sauer, R. H. 1988. Self-revegetation of disturbed ground in deserts of Nevada and Washington. Northwest Sci. 56: 41-46.

Ritchie, M. E., M. L. Wolfe, and R. Danvir. 1994. Predation of artificial sage grouse nests in treated and untreated sagebrush. Great Basin Naturalist 54:122-129.

Rittenhouse, L. R., and F. A. Sneva. 1976. Expressing the competitive relationship between big sagebrush and crested wheatgrass. Journal of Range Management 29:326-327.

Roberts, T. C., Jr. 1991. Cheatgrass: management implications in the 90's. Rangelands 13:70-72.

Robertson, M. D. 1991. Winter ecology of migratory sage grouse and associated effects of prescribed fire in southeastern Idaho. Thesis, University of Idaho, Moscow, Idaho, USA.

Robinson, I. B. 1982. Drought relief schemes for the pastoral zone. Australian Rangeland Journal 4:67-77.

Robinson, W. B. 1961. Population changes of carnivores in some coyote-control areas. Journal of Mammalogy 42:510-515.

Rogers, G. F. 1982. Then and now: A photographic history of vegetation change in the central Great Basin desert Univ. Utah Press. Salt Lake City, UT.

Rose, K. K. 1999. Sustainable control of dalmation toadflax (Linaria genistifolia spp), musk thistle (Carduus nutans), and downy brome (Bromus tectorum) using cool-season, perennial grass competition. Thesis. Department of Plant Science, University of Wyoming, Laramie, Wyoming, USA.

Rose, J. A., Miller R. F., and Svejcar, T. 1994. Vegetation and livestock exclusion in the sagebrush steppe. In: Management of Great Basin rangelands. OR State Univ., Agric. Exp. Sta. Special Rep. 935 p 53-59.

Roseberry, J. L. 1979. Bobwhite population responses to exploitation: real and simulated. Journal of Wildlife Management 43:285-305.

Ryan, K. C. 2000. Global change and wildland fire. In: Wildland fire in ecosystems: Effects of fire on flora. Eds. Brown, J. K. and Smith, J. K. Gen Tech. Rep. RMRS-GTR-42 vol. 2. Ogden, UT. USDA, For. Serv,, Rocky Mt. Res. Stat. pp 175-183.

Salih, Mohamed S.S.; Taha, F. H.; and Payne, G. F. 1973. Water repellency of soils under burned sagebrush. Journal of Range Management 26(5): 330-331.

Samuel, M. J., and G. S. Howard. 1982. Botanical composition of summer cattle diets on the Wyoming high plains. Journal of Range Management 35:305-308.

Sanera, M. and J. S. Shaw. 1996. Facts Not Fear. Regnery Publishing Inc. ISBN 0-89526-488-X

Sargeant, A. B. 1972. Red fox spatial characteristics in relation to waterfowl predation. Journal of Wildlife Management 36:225-236.

Sargeant, A. B., M. A. Sovada, and R. J. Greenwood. 1987. Responses to three prairie ground squirrel species, Spermophilus franklinii, S. richardsonii, and S. tridecemlineatus, to duck eggs. The Canadian Field-Naturalist 101:95-97.

Savage, D. E. 1969. The relationship of sage grouse to upland meadows in Nevada. Transactions of the Annual. Meeting, California-Nevada Section of The Wildlife Society 16:8-17.

Savory, A. 1988. Holistic resource management. Island Press. Washington D. C., USA.

Schneegas, E. R. 1967. Sage grouse and sagebrush control. Transactions of the North America Wildlife and Natural Resource Conference 32:270-274.

Schoenburg, T. J. and C. E. Braun. 1982. Potential impacts of strip mining on sage grouse movements and habitat use. Colorado Division of Wildlife. Job Completion Report. Federal Aid Project W-37-R-35, Work Plan 3, Job 12.

Schranck, B. W. 1972. Waterfowl nest cover and some predation relationships. Journal of Wildlife Management 36:182-186.

Schroeder, M. A. 1997. Unusually high reproductive effort by sage grouse in a fragmented habitat in north-central Washington. Condor 9:378-385.

Schroedl, G. F. 1973. The archeological occurrence of bison in the Southern Plateau. Washington State University Lab of Anthropology. Report of Investigation 51. Pullman, Washington, USA.

Schuman, G. E., D. T. Booth and J. R. Cockrell. 1998. Cultural methods for establishing Wyoming big sagebrush on mines lands. Journal of Range Management 51:223-229.

Schuman, G. E., E. M. Taylor, Jr., F. Rauzi. 1991. Forage production of reclaimed mined lands as influenced by nitrogen fertilization and mulching practice. Journal of Range Management 44:382-384.

Sime, C. A. 1991. Sage grouse use of burned, non-burned, and seeded vegetation communities on the Idaho National Engineering Laboratory, Idaho. Thesis. Montana State University, Bozeman, Montana, USA.

Simon, F. 1940. The parasites of the sage grouse. University of Wyoming Publication 7:77-100.

Small, R. J., Holzwart, J. C., and Rusch, D. H. 1991. Predation and hunting mortality of ruffed grouse in central Wisconsin. Journal of Wildlife Management 55:512-520.

Smith, G. J. 1987. Pesticide Use and Toxicology in Relation to Wildlife: Organophosphorus and Carbamate Compounds. United States Department of the Interior, Fish and Wildlife Service.

Sneva , F. A., Rittenhouse, R. L., Tueller, P. T. and Reece, P. 1984. Changes in protected and grazed sagebrush-grass in eastern Oregon, 1973-1974. OR State Univ. Agric. Exp. Sta. Bull. 663. 11p.

Stabler, R. M., C. E. Braun, and T. D. I. Beck. 1977. Hematozoa in sage grouse from Colorado. Journal of Wildlife Disease 13:414-417.

Stahlecker, D. W. 1978. Effect of a new transmission line on wintering prairie raptors. Condor 80:444-446.

Steen, H., N. G. Yoccoz, and R. A. Ims. 1990. Predators and small rodent cycles: an analysis of a 79-year time series of small rodent population fluctuations. Oikos 59:115-120.

Stigar, M. S. 1989. Hunting low density sage grouse populations. Thesis. University of Nevada, Reno, Nevada, USA.

Stohlgren, T. J., L. D. Schell, and B. Vanden Heuvel. 1999. How grazing and soil quality affect native and exotic plant diversity in Rocky Mountain grasslands. Ecological Applications 9:45-64.

Strong, L. 1993. Overview: the impact of avermectins on pastureland ecology. Veterinary Parasitology 48:3-17.

Sturges, D. L. 1983. Long term effects of big sagebrush control on vegetation and soil water. Journal of Range Management 36:760-765.

Sturges, D. L. 1993. Soil-water and vegetation dynamics through 20 years after big sagebrush control. Journal of Range Management 46:161-169.

Sveum, C. M., J. A. Crawford, and W. D. Edge. 1998. Use and selection of brood-rearing habitat by sage grouse in south-central Washington. Great Basin Naturalist 58:344-351.

Swanson, F.J., J.A. Jones, D.O. Wallin, and J.H. Cissel. 1994. Natural variability—Implications for ecosystem management. In: Eastside forest ecosystem health assessment: Volume II: Ecosystem Management: Principles and applications. M.E. Jensen and PIS. Bourgerom (eds.). USDA, For. Serv. Gen. Tech. Rep. PNW-GTR-318. p 80-94.

Swenson, J. E. 1986. Differential survival by sex in juvenile sage grouse and gray partridge. Ornis Scandinavica 17:14-17.

Swenson, J. E., C. A. Simmons, and C. D. Eustace. 1987. Decrease of sage grouse Centrocercus urophasianus after ploughing of sagebrush steppe. Biological Conservation 41:125-132

Tapper, S. 1979. The effect of fluctuating vole numbers (Microtus agrestis) on a population of weasels (Mustela nivalis) on farmland. Journal of Animal Ecology 48:603-617.

Tart, D.L. 1996. Big sagebrush plant associations of the Pinedale Ranger District, Pinedale, WY. USDA, For. Ser., Bridger-Teton National Forest. Jackson, WY. 97p.

Taylor, R. G., J. R. Workman, and J. E. Bowns. 1979. The economics of sheep predation in southwestern Utah. Journal of Range Management 32:317-321.

Taylor, S. M. 1999. Sheep scab – environmental considerations of treatment with doramectin. Veterinary Parasitology 83:309-317.

Thurow, T. L. and C. A. Taylor. 1999. Viewpoint: the role of drought in range management. Journal of Range Management 52:413-419.

Tidewell, W. D., S. R. Rashforth, and D. Simper. 1972. Evolution of floras in the intermountain region. Volume 1 in A. Cronquist, A. H. Cronquist, H. H. Holmgren, and J. L. Reveal (editors). Intermountain flora. Hafner Publishing Company. New York, New York, USA.

Tigner, J. R. and G. E. Larson. 1977. Sheep losses on selected ranches in southern Wyoming. Journal of Range Management 30:244-252.

Tisdale, E. W. 1994. Great Basin region: sagebrush types. In: T. N. Shiflet (ed.) Rangeland cover types. Soc. Range Manage., Denver, CO p40-46.

Tisdale, E. W., and M. Hironaka. 1981. The sagebrush-grass region: a review of the ecological literature. Idaho Forest, Wildlife and Range Experiment Station Bulletin 33. Moscow, Idaho, USA.

Tisdale, E. W., M. Hironaka and F.A. Fosberg. 1965. An area of pristine vegetation in Craters of the Moon National Monument, Idaho. Ecology 46: 349-352.

Tisdale, E. W., M. Hironaka and F.A. Fosberg. 1969. The sagebrush region in Idaho: a problem in range resource management. Univ. ID Agric. Exp. Sta. Bull. 512. 15p.

TRC Mariah Associates Inc. 1997. Environmental impact statement for the Jonah Field II natural gas development project, Sublette County, Wyoming. Draft Wildlife Technical Report.

Trueblood, R. W. 1954. The effects of grass reseeding in sagebrush lands on sage grouse populations. Thesis. Utah State Agriculture College, Logan, Utah, USA.

Tueller, P. T. 1973. Secondary succession, disclimax, and range condition standards in desert shrub vegetation. In: Arid Shrubland Proc., 3rd US/Australian Rangeland Panel. D. N. Hyder (ed.) Denver, CO. p 57-65.

Tueller, P. T., and Blackburn, W. H. 1974. Condition and trend of the big sagebrush/needleandthread habitat type in Nevada. Journal of Range Management 27: 36-40.

Tueller, P. T. and Platou, K. A. 1991. Plant succession gradient in a big sagebrush/grass ecosystem. Vegetatio. 94:57-68.

United States Department of Interior Bureau of Land Management. 1979. Kemmerer resource area oil and gas leasing environmental assessment record. Bureau of Land Management, Rock Springs District, Wyoming, USA.

United States Department of Interior Bureau of Land Management. 1999. Wyodak coal bed methane project draft environmental impact statement. BLM, Buffalo Field Office, Buffalo, Wyoming, USA.

Vale, T. R. 1974. Sagebrush conversion projects: an element of contemporary environmental change in the western United States. Biological Conservation 6(4):274-284.

Vale, T. R. 1975. Presettlement vegetation in the sagebrush-grass area of the intermountain west. Journal of Range Management 28:32-36.

Valentine, K. A. 1947. Distance from water as a factor in grazing capacity of rangeland. Journal of Forestry 45:749-754.

Vavra, M., R. W. Rice, R. M. Hansen, and P. L. Sims. 1977. Food habits of cattle on shortgrass range in northeastern Colorado. Journal of Range Management 30:261-263.

Vincent, D. W. 1992. The sagebrush/grasslands of the upper Rio Puerco area, New Mexico. Rangelands 14(5): 268-271.

Voigt, D. R., and B. D. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38:630-633.

Wakkinen, W. L. 1990. Nest site characteristics and spring-summer movements of migratory sage grouse in southeastern Idaho. Thesis. University of Idaho, Moscow, Idaho, USA.

Wakkinen, W. L., K. P. Reese, and J. W. Connelly. 1992. Sage grouse nest locations in relation to leks. Journal of Wildlife Management 56:381-383.

Walker, J. W., R. K. Heitschmidt, and S.L. Dowhower. 1989. Some effects of a rotational grazing treatment on cattle preference for plant communities. Journal of Range Management 42:143-148.

Wallestad, R. O. 1971. Summer movements and habitat use by sage grouse broods in central Montana. Journal of Wildlife Management 35:129-136.

Wallestad, R. O. 1975. Life history and habitat requirements of sage grouse in central Montana. Montana Fish and Game Department Technical Bulletin, Helena, Montana, USA.

Wallestad, R. O., and D. B. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal Wildlife Management 38:630-633.

Wallestad, R. O., and P. Schladweiller. 1974. Breeding season movements and habitat selection of male sage grouse. Journal of Wildlife Management 38:634-637.

Ward, J. C. 1940. The susceptibility of sage grouse to Strychnine. Wildlife Research Laboratory, U.S. Department of the Interior, Denver Colorado, USA.

Watts, M. J., and C. L. Wambolt. 1996. Long-term recovery of Wyoming Big sagebrush after four treatments. Journal of Environmental Management 46(1):95-102.

Welch, B. L., E. D. McArthur, and R.L. Rodriguez. 1987. Variation in utilization of big sagebrush accessions by wintering sheep. Journal of Range Management 40:113-115.

Welch, B. L., F. J. Wagstaff, and J. A. Robertson. 1991. Preference of wintering sage grouse for big sagebrush. Journal of Range Management 44(5):462-465.

West, N. E. 1983. Western Intermountain sagebrush steppe. In: N.E. West (ed.) Ecosystems of the World 5.: Temperate deserts and semi-deserts. Elseviier Scientific Publ. Co., New York, NY p 351-397.

West, N. E. 1988. Intermountain deserts, shrub steppes, and woodlands. In: M.B. Barbour and W.D. Billings (eds.) North American Terrestrial Vegetation. Campbidge Univ. Press. p 209-230.

West, N. E. 1999. Manageing for biodiversity of rangelands. In: Biodiversity in agrosystems. W.W. Collins and C. O. Qualset (eds.). CRC Press. p 101-120

West, N. E. and Hassan, M. W. 1985. Recovery of sagebrush-grass vegetation following wildfire. Journal of Range Management 38(2): 131-134.

Whitson, T. D. and H. P. Alley. 1984. Tebuthiuron effects on Artemisia spp. and associated grasses. Weed Science 32:180-184.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, and R. Parker. 1991. Weeds of the west. Western Society of Weed Science and Western United States Land Grant Universities Cooperative Extension Services, University of Wyoming, Laramie, Wyoming, USA.

Whitson, T. D., M. A. Ferrell, and H. P. Alley. 1988. Changes in rangeland canopy cover seven years after Tebuthiuron application. Weed Technology 2:486-489.

Willis, M. J.,G. P. Kiester. Hr., D. A. Immel, D. M. Jones, R. M. Powell, and K. R. Durbin. 1993. Sage grouse in Oregon. Oregon Department of Fish and Wildlife, Wildlife Research Report No. 15.

Wilson Bulletin Conservation Committee. 1976. Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-170.

Winward, A. H. 1980. Taxonomy and ecology of sagebrush in Oregon. Sta. Bull. 642. Agric. Exp. Sta. Oregon State, Univ., Corvallis, OR.

Winward, A. H. 1985. Fire in the sagebrush-grass ecosystem - the ecological setting. Pages 2-6 *in:* Sanders K., and J. Durham [and others],editors. Rangeland fire effects : a symposium ; Proceedings. United States Department of Interior, Bureau of Land Management. Boise, Idaho, USA.

Winward, A. H. 1991. A renewed commitment to management of sagebrush grasslands. Agricultural Experiment Station Special Report 880. Oregon State University, Corvallis, Oregon, USA.

Winward, A. H. and E.W. Tisdale. 1977. Taxonmy of *Artemisia tridentata* complex in Idaho. Bull. No. 19. Univ. of Idaho, College of Forestry, Wildlife and Range Sciences, Moscow, ID.

Workman, J. P. 1986. Range Economics. Macmillan Publishing Co. New York, New York, USA.

Wright, H. A. 1970. Responses of big sagebrush and three-tip sagebrush to season of clipping. Journal of Range Management 23:20-22.

Wright, H. A. 1974. Range burning. Journal of Range Management 27:5-11.

Wright, H. A. 1979. The role and use of fire in sagebrush grass and pinyon juniper plant communities. A state-of-the-art review. United States Department of Agriculture, Forest Service General Technical Report INT-58.

Wright, H. A. 1986. Effect of fire on arid and semi-arid ecosystems – North American Continent. In: Rangelands! A resource under siege. Proc. 2nd International Rangeland Congress. Cambridge Univ. Press: 575-576.

Wright, H. A., and A. W. Bailey. 1982. Fire ecology. United States and southern Canada. Wiley and Sons, New York, New York, USA.

Wrobleshi, D. W. 1999. Effects of prescribed fire on Wyoming big sagebrush communities: Implications for ecological restoration of sage grouse habitat. M. S. Thesis. OR State Univ., Corvalllis, OR.

Wyoming Game and Fish Department. 1992. Vertebrate Species List. Wyoming Game & Fish Dept., Cheyenne, WY.

Wyoming Interagency Vegetation Committee. 2002.Wyoming guidelines for managing sagebrush communities with emphasis on fire management. Wyoming Game and Fish Department and Wyoming BLM, Cheyenne, WY 53p.

Wyoming Shrub Ecology Workshop. 1982. Tour Stop Notes. Univ. Wyo. Dept. Range Manage. Laramie, WY.

Young, J. A., R. E. Eckert, Jr., and R. A. Evans. 1979. Historical perspectives regarding the sagebrush ecosystem. In: The sagebrush ecosystem: A symposium; 1978 April. Logan, UT. UT State Univ., College of Natural Resources. p 1-13.

Young, J. A. and R. A. Evans. 1981. Demography and fire history of a western juniper stand. Journal of Range Management 34: 501-506.

Young, J. A., R. A. Evans, R. E. Eckert, Jr., and B. L. Kay. 1987. Cheatgrass. Rangelands 9:266-270.

Zablan, M. A. 1993. Evaluation of sage grouse banding program in North Park, Colorado. Thesis. Colorado State University, Fort Collins, Colorado, USA.

Zamora, B. and P. T. Tueller. 1973. *Artemisia arbuscula, A. longiloba* and *A. nova* habitat types in northern Nevada. Great Basin Naturalist 33: 225-242.

Zunino, G. W. 1987. Harvest effect on sage grouse densities in northwest Nevada. Thesis. University of Nevada, Reno, Nevada, USA.

Appendix 1

POPULATION MONITORING AND ASSESSMENT*

One of the primary components of an effective sage-grouse conservation strategy will be the continued development and utilization of a standardized population monitoring program capable of producing meaningful, rigorous status and trend information. This monitoring program should result in regular reports being generated by the WGFD that can be used by local planning groups to analyze local situations and implement local conservation plans. These data should also be suitable for aggregate analysis at the statewide level and comparison to similar data sets from other states. The Wyoming Sage-Grouse Database has recently been developed. This database incorporates lek survey and count data as well as harvest data, including determination of the age and sex from wings deposited in hunter collection barrels. As this database comes into use, it should provide the basis for both local and statewide analysis of sage-grouse population status and trend.

Breeding Populations

Sage-grouse gather on traditional display areas (leks) each spring, affording the opportunity for tracking breeding populations. Methods include lek censuses (annually counting the number of male sage-grouse attending leks in a given area), lek complex routes (annually counting the number of male sage-grouse on a group (complex) of leks that are relatively close and represent part or all of a single breeding population), and lek surveys (annually counting the number of active leks in a given area). All monitoring procedures are conducted during early morning (1/2 hour before to 1 hour after sunrise), with reasonably good weather (light or no wind, partly cloudy to clear) from early March to early May. Timing is dependent on elevation of leks and persistence of winter conditions. Sage-grouse will begin displaying in late February at lower elevations with milder climates and in years with mild winter weather. Lek attendance will persist into early or mid-May at higher elevations.

All lek data should be collected and reported as defined below.

Lek. A traditional courtship display area attended by male sage-grouse in or adjacent to sagebrush dominated habitat. Designation of the site as a lek requires observation of two or more male sage-grouse engaged in courtship displays. In addition new leks must be confirmed by a survey conducted during the appropriate time of day and during the strutting season. Observation of sign of strutting activity can also be used to confirm a suspected lek.

* - based on Sage Grouse Methodology Committee Report on Sage Grouse Management Practices to the 1996 Western States Sage Grouse Workshop - Gillette, Wyoming and Monitoring of Sage Grouse Habitats and Populations Draft by J.W. Connelly, K.P. Reese and M.A. Schroeder, January 2002. Metric measures have been converted and rounded to English units for this appendix.

Lek Complex. A group of leks in close proximity between which male sage-grouse may be expected to interchange from one day to the next. A specific distance criteria does not yet exist.

Lek Count. A census technique that documents the actual number of male sage-grouse observed on a particular lek or complex of leks using the methods described below.

Lek Survey. A monitoring technique designed primarily to determine whether leks are active or inactive and obtaining accurate counts of the numbers of males attending is secondary.

Annual status – Each year a lek will be determined to be in one of the following status categories:

Active. Any lek that has been attended by male sage-grouse during the strutting season. Presence can be documented by observation of birds using the site or by signs of strutting activity.

Inactive. Leks where it is known that there was no strutting activity through the course of a strutting season. A single visit, or even several visits, without strutting grouse being seen is not adequate documentation to designate a lek as inactive. This designation requires either an absence of birds on the lek during multiple ground visits under ideal conditions throughout the strutting season or a ground check of the exact lek site late in the strutting season that fails to find any sign (droppings/feathers) of strutting activity.

Unknown. Leks that have not been documented either active or inactive during the course of a strutting season.

Based on annual status a lek may be put into one of the following categories for management purposes:

Occupied Lek. A lek that has been active during at least one strutting season within the last ten years. Management protection will be afforded to occupied leks.

Historical Lek. A lek that has not been active during a consecutive ten-year period. A historic lek is one that has been surveyed or counted without male grouse or signs of strutting activity being observed in at least six strutting seasons spanning ten years. In addition the lek must be confirmed as inactive at least two of those ten years. A lek may also be designated as historic if the lek site and the adjoining sagebrush habitat have been destroyed (e.g. type conversion). Management protection will not be afforded to historical leks.

Undetermined Lek. Any lek that has not been documented as being active in the last ten years but does not have sufficient documentation to be designated historical. Management protection will be afforded to undetermined leks until their status has been documented as historical.

Locating Leks--Before a monitoring program for sage-grouse breeding populations can be designed, lek locations must be documented. Leks can be located by searching from the ground or air from early March to early May.

Helicopters or fixed-wing airplanes can be used for air searches. Strutting cocks are highly visible as the early morning sun shines on their white chests. Suspected breeding habitat should be flown on north - south transects with lines about ½ mile apart. Aerial searches are biased toward finding larger leks; small leks (<15 birds) are more difficult to detect. Calm, clear mornings are prerequisite to aerial searches. Winds over 15 mph and more than scattered cloud cover should be sufficient to cancel search flights. Cocks can be observed from the air at distances greater than a ½ mile in early morning sun, but cloud cover greatly reduces observability. Under conditions of marginal light, transect width should be narrowed. High winds not only make traveling a straight transect difficult, but also affect strutting behavior. Fewer cocks will strut continuously, and flushing distance appears to be greater under windy conditions.

Transects should be flown at about 300 feet above ground level. Whenever possible, two observers should be used in addition to the pilot so that one observer is always looking away from the sun regardless of the direction the aircraft is flying. Searches should begin at the east edge of the survey area and work west to minimize the possibility of the plane flying over leks prior to them being observed. Special attention should be paid to old lakebeds, stock-watering areas, and other relatively open sites largely surrounded by sagebrush with 15 to 25% canopy cover. Lek searches from an aircraft should be conducted from ½ hour before to one hour after sunrise, although during peak attendance the time can be stretched to 1½ hours after sunrise.

Cock behavior in response to approaching aircraft varies, but may affect search success. Strutting may continue as the plane approaches and flies near or over the lek, but in other instances, grouse have been observed squatting similar to that seen when an avian predator approaches. Sage-grouse virtually disappear when they squat, making it essential to locate cocks prior to close approach or fly over by the aircraft. Observers should continually strive to observe strutting cocks at a distance. Research has found that aerial count estimates can be up to a third less than ground counts. Therefore aerial counts are not usually considered adequate for monitoring trends in lek attendance, although efforts have been made in Nevada to develop a counting technique using helicopters.

In areas with no recent history of sage-grouse use or poor habitat, aircraft speed can be increased and search intervals increased to 1 mile. In areas where habitat alteration or human development is anticipated, narrower transect widths may be advisable to better ensure that the area is thoroughly searched.

Lek searches can be conducted from the ground by driving along roads in suspected or known breeding habitat and stopping every ½ mile to listen for sounds of breeding grouse. Ground searches can be started an hour before sunrise. In less accessible areas, searches can be made from a mountain bike, trail motorcycle, 4-wheel all terrain

vehicle, horseback or on foot. On a calm morning, breeding sage-grouse may be heard at a distance of almost 1 mile. All openings or areas of less dense sagebrush should be searched for breeding birds with binoculars or a spotting scope.

A variation of the ground survey can be used following snowfall during the night or early morning. Although lek activity is minimal during stormy weather and the birds may flush at the first sign of an intruder, some male sage-grouse will attend leks on virtually every morning during the spring, regardless of weather. Areas that are suspected of being leks can be searched immediately following a snowfall. If grouse use the area, tracks will be evident in the snow, and the number of tracks may give some indication of the relative size of the lek. Similarly, new leks can be located by the discovery of concentrated tracks/droppings/feathers at all times of the day when conducting other field activities (big game winter mortality transects). Return visits to such sites during the morning strutting hours must be made to confirm the location as a lek.

Not every site where sage-grouse are seen to strut is a strutting ground. Grouse that have been flushed from their lek will often resume strutting in a different site for the rest of that morning, and then return to the normal lek the following night. Juvenile cocks will sometimes pursue hens as they leave a lek, strutting as a group as far away as ½ mile from the lek as they follow the females. Care needs to be taken that a site identified as a strutting ground is truly a lek. Strutting activity should be documented at a site on at least two mornings before it is designated as a lek. Ground survey of the site to search for sign of prolonged activity can also separate true leks from temporary strutting sites.

The center point of all leks should be recorded in UTMs using NAD83 datum and stored within the Wyoming Sage-Grouse Database. Additionally, it is advisable to record/map the perimeters of all leks.

Lek Counts--Lek counts are a common means of monitoring sage-grouse populations. Lek counts document the actual number of male sage-grouse observed on a particular lek or complex of leks. A lek complex is a group of leks in close proximity between which male sage-grouse may be expected to interchange.

Although lek counts are widely used, concern over their usefulness has been expressed. However, techniques for correctly conducting lek counts have been described herein and problems generally seem to be related to disregarding accepted techniques. Reviews of raw data recorded while conducting lek routes have indicated that some leks have been counted at the wrong time of the year or during periods of wind or precipitation. All participants in lek counts should receive adequate training in the proper techniques. Video training guides (Power Point format) are available.

The following criteria should be used to insure the quality and utility of the count data:

1) Lek counts should be conducted every 7-10 days over a 3-4 week period following the peak of mating activity. Peak breeding usually occurs in early April in Wyoming, however peak male attendance usually occurs in late April or early May when yearling males show increased lek attendance rates.

2) Counts should only be conducted from the ground.
3) Counts should be made between ½ hour before to 1 hour after sunrise.
4) Counts should be conducted a minimum of three times each year for each lek.
5) Counts should only be conducted if wind speeds are less than 5 mph and there is no precipitation occurring.

Subdominant males are often less active than more dominant males occupying the center of the lek. These subdominant birds may be easily missed with a single count. A lek may be effectively counted in the following manner:

1) Locate a spot that provides good visibility of the entire lek. If the lek is very large (100 or more birds) it may be necessary to select two or more vantage points. Be careful not to get so close that an observer's presence disturbs the grouse.
2) Record the time that the lek count begins.
3) Count the birds from left to right (or vice versa).
4) Wait one to two minutes, then count from right to left.
5) Wait one to two minutes, then again count from left to right.
6) Record the highest number of males and females separately, and then move to the next lek.

Because some sage-grouse may use several leks in a given breeding season, changes in lek attendance observed during a lek count may be due to some birds shifting to nearby leks. Moreover, a single lek could disappear because of disturbance or vegetation change. The disappearance may or may not mean that the actual population is declining. Therefore, all leks within a complex should be counted during a lek census to access actual changes in the grouse population.

A lek complex route is a type of lek count with an important distinction—an attempt is made to census a group of leks that are relatively close and represent part or all of a single breeding population. Leks should be counted along routes to facilitate repetition by other observers, increase the likelihood of recording satellite leks, and account for shifts in breeding birds if they occur. Lek complex count routes should be established so that all leks along the route can be counted within 1.5 hours. If weather degenerates after a lek complex route has begun, the route should be run again.

If a lek is not occupied (and it had been in previous weeks or years), the observer should leave his/her vehicle and (with the engine off) listen for sounds of displaying grouse. Leks will move if birds are subject to continuing disturbance. Grouse may also be flushed from a lek by a predator and, if it is still reasonably early in the morning, may display nearby once the predator leaves the area.

Before establishing lek counts/routes in a given area, some thought should be given to personnel available for conducting routes. It is much better to have a few counts with high quality data than many with less than adequate data. Lek count routes should be coordinated through and assigned by the WGFD, although trained persons from outside the agency might collect lek count data. Those leks with a long history of consistent data collection are highly recommended to be included in count routes. A minimum of

one lek count route should be conducted in each management area occupied by sage-grouse.

Lek count data should be recorded on the standardized statewide reporting form and recorded in the Wyoming Sage-Grouse Database.

Lek Surveys— Ideally, all sage-grouse leks would be count leks. However, some sage-grouse breeding habitat is inaccessible during spring because of mud and snow, or so remote that leks cannot be routinely counted. Other leks may be situated in topography or vegetation that does not allow an accurate count of males from any vantage point. In addition, time and budget constraints limit the number of leks that can be visited. In these cases, lek surveys are the only reliable means of monitoring these populations. Lek surveys are designed primarily to determine whether leks are active or inactive. Only one visit to the lek is required and obtaining accurate counts of the numbers of males attending is secondary. Surveys require less manpower and time than lek counts. They can also be conducted from fixed-wing aircraft or helicopter. Because obtaining a peak male count is not a priority, surveys of leks not on count routes can begin with initiation of strutting in early March and extend into early-mid May, depending on the site and spring weather.

The major drawback to this technique is that it is not sensitive to a change in sage-grouse population size unless the sample size of leks is very large. As an example, a group of 5 leks could have had 50 males observed during one spring survey and 75 males observed two years later. These results should only be interpreted to mean that all 5 leks were active each year surveyed. What appears to be a 50% increase may not be the case. However, on a very large scale, Wyoming lek survey data have been shown to be consistent with lek count data population trends (up, down, stable).

To provide the most useful information on population trends, lek surveys should be conducted in the same manner and during the same time period each year. In other words, they should not be conducted from a fixed-wing aircraft one year and a helicopter the next year or in early March one year and in May the next. The date and time should be recorded for each survey. UTM coordinates for each lek encountered should also be noted, as well as any other information that observers might consider important. Although it is difficult to get an accurate count of birds from an aircraft, it is usually possible to estimate the number of birds present.

The activity status of leks whose exact location is known can be checked at any time of the day, and for a short period after the strutting season, by looking for signs of strutting activity. Sites used by sage-grouse for strutting are easily identified by heavy concentrations of scattered fecal pellets (not in discrete piles beside sagebrush, as is common on winter ranges), feathers, tracks and trampled vegetation. Strutting sites are usually marked by large numbers of caecal droppings (miniature black "cow pies"). Caecal droppings are initially green, but cure to black quickly in the sun. Presence of green caecal droppings and fresh tracks can be used to determine if a lek site was active that morning. Sage-grouse fecal droppings can last for years, although fading with time, but caecal droppings usually decay within days or weeks, depending on

precipitation, limiting the time that this sign can be used to document lek activity. Ground visits to the exact strutting center of a lek also provides an ideal opportunity to get the lek location accurately and precisely mapped, using either GPS technology or orthophoto quad maps.

As with lek counts, the ideal time for lek surveys is from about 1/2 hour before until 1 hour after sunrise, but sage-grouse will occasionally strut as late as two hours or more after sunrise. Late attendance on leks usually coincides with either 1) presence of hens on the lek, 2) overcast skies, fog, or light snowfall with dim light, or 3) during the small, or "new" phases of the moon, when little strutting activity occurs at night. Males will generally cease strutting activity early on mornings when hens are absent (late in the strutting season) or near the full moon, when much of the strutting and breeding occurs at night. At and near the full moon, sage-grouse may strut all night and males will occasionally initiate strutting at sunset or shortly after sunset. At these times, leks can occasionally be checked in the evening. While not providing a count of attendance, lek surveys can and have been conducted at night during the full moon, provided leks can be approached close enough to either hear or spotlight strutting grouse.

The frequency with which known leks are surveyed is based on manpower, budgets and rates of habitat alteration or development. Remote leks should be surveyed at least once every three years and others more frequently. Increasing public interest in sage-grouse has afforded the opportunity to utilize volunteers to survey or count leks and thus increase data collection efforts. The Wyoming Wildlife Federation's "Adopt-a-Lek" program has shown to provide a pool of reliable volunteers. Volunteers should be properly trained in monitoring techniques to ensure quality data and not disrupt breeding activity.

Data Analysis-- Prior to analysis, field data should be reviewed to ensure that information was collected properly. Lek count routes conducted during stormy weather, high winds or late in the morning (i.e., routes completed more than 1.5 hours after sunrise) should not be included in the analysis.

To assess breeding population trends, the minimum amount of information needed is a record of the number of active leks in a given area over a period of years. This information can be obtained from lek surveys and lek routes, but these data will only reflect gross changes in the population and may provide misleading results.

Lek count data that have been correctly collected provide more useful data for assessing population trends than information on the number of active leks. Lek counts provide the following data: active leks/route; average number of males/route or complex; maximum number of males/route or complex; average number males/lek; maximum number of males/lek; and possibly, males/area (all males counted on a group of lek routes). Sometimes the number of leks along a route changes because the route has changed, the habitat has changed or satellite leks have developed. If this occurs, then the most effective means of tracking populations and analyzing changes will be by examining the number of males per lek. If the number of leks does not change over a

period of years, the number of males per route should form the basis of breeding population assessment.

Females are usually counted along lek routes, but because of their secretive nature and cryptic appearance they are difficult to detect. Although the number of females counted may provide some information on peak of breeding, these data should not be used to assess population change.

The development of the Wyoming Sage-Grouse Database and Job Completion Report has facilitated data storage, retrieval, analysis and reporting on both regional and statewide levels. All current and historical data should be entered into the database.

Production

Brood observations, brood routes and wing surveys have been used to assess sage-grouse production. Brood observations, sometimes called random brood routes, are simply records of all sage-grouse broods observed in a given area by any field personnel that find themselves in that area. This information provides some idea of the juvenile to adult ratio and percent of hens observed with broods. Thus, it is somewhat better than anecdotal data. However, it is not easily replicated and comparisons among years can be difficult to interpret.

Routes are usually conducted on foot, horseback or driven at speeds <20 mph in the morning (sunrise to about 0900) and evening (1800 to sunset) during late June, July and early August. Brood routes are normally established in areas known to have concentrations of sage-grouse. These areas are often in or adjacent to wet meadows, riparian zones and agricultural fields. Each brood is recorded separately and the presence of a hen is also recorded. Groups of unsuccessful females and males are also normally tallied. Because chicks are quite secretive it is usually necessary to flush the brood to obtain an accurate count. A trained bird dog can increase the efficiency of this procedure. If sufficient numbers of grouse are observed such that the sample size is adequate, this technique can provide a reliable indication of trends in production. Brood routes provide the following information: birds/km, broods/km, average brood size, and chick to adult hen ratio. For non-hunted populations or populations subject to very light hunting where relatively few wings can be collected, brood routes are the only method available for assessing production, short of using radio telemetry.

Sage-grouse wings collected during hunting seasons can be used to determine age and gender of harvested birds. For hunted populations, wing surveys are the most useful technique for assessing sage-grouse production (chicks/hen). However, sample sizes should exceed 150 wings, and could be considerably larger depending on the size of the area and population being sampled. Wings are normally collected at wing barrels or hunter check stations. The Wyoming Game & Fish Department's Sage-Grouse Sex and Age Guide should be used to determine age and gender of wings. Wings are usually read at an annual "wing-bee" held in November of each year. The wing-bee format allows for experience and expertise to be shared between participants.

Wing analyses and brood routes allow an assessment of trends in production and a comparison of production among areas. However, these data may not reflect population trends. For example, a portion of a population's winter habitat may be lost but the breeding range could remain intact. Production (juvenile to adult ratio) may be stable but the overall population may decline because of increased mortality on winter range. Thus, it is best to use this information in conjunction with data on breeding populations to make inferences on population trends.

Wing data should be entered into the Wyoming Sage-Grouse Database.

Winter Populations

Unlike breeding populations and production, there are no widely accepted methods for assessing winter populations. In part, this is because birds may be spread out over large areas during mild winters but concentrated in a relatively small proportion of the area in severe winters.

Probable winter use areas can be searched by 4-wheel drive vehicle, snowmobile, or on foot to document sage-grouse winter habitat. Aerial surveys using either a fixed-wing aircraft or helicopter may also be effective in identifying sage-grouse winter habitats and can often be done in conjunction with surveys for other wildlife (e.g. elk trend counts/classifications). Data collected should include at least approximate flock size and location. In addition, cover type (including sagebrush species present), topography, and snow depth data are also valuable but may not be possible to obtain from the aerial observations. Data should be acquired over a series of years with different snow conditions to give a more complete picture of winter grouse distribution.

Falconers can be a good source of winter distribution information and many have volunteered to collect and record winter locations.

Appendix 2

Nesting and Early Brood-rearing Habitat Methods and Descriptions

Vegetation variables were measured at nest sites, early brood-rearing habitat, and independent random locations at five study sites in Wyoming from 1994-2002.

Female sage-grouse were captured on and near leks from mid-March through April, 1994-2002 by spot-lighting and hoop-netting. Each captured hen was aged [yearling (<2 years old) or adult (≥2 years old)] based on the shape of the outermost wing primaries and fitted with a radio transmitter package secured with a PVC-covered wire necklace and situated on the breast.

Radio-marked sage-grouse hens were monitored bi-weekly through the pre-laying (April) and nesting (May-June) periods using hand-held receivers and 3-element Yagi antennas. Nest locations of radio-marked hens were determined by circling the bird until they could be observed. Rubber boots were worn while confirming nest locations to reduce human scent, and incubating hens were monitored after nest identification from a distance of ≥60 meters to minimize the chance of human-induced nest predation or nest abandonment.

Nests were examined to determine fate (successful or unsuccessful) when long-range monitoring indicated a hen had left the nest area. Nests were considered successful if ≥1 egg hatched, determined by the presence of a detached shell membrane.

Vegetation was evaluated between late May and early June at nest sites and independent random locations. To minimize differences resulting from herbaceous growth, vegetation was evaluated at successful nests, unsuccessful nests, and random plots concurrently following the first successful hatch. Standardized data collection protocol was used among the responsible individuals to reduce bias in measuring vegetative characteristics. The location of independent random sites was determined by randomly generating UTM coordinates for the study area. To ensure that random locations adequately represented available nesting habitat, the closest sagebrush plant taller than 35 centimeters (to the randomly generated point) was used as the center for the random plot.

Vegetation was evaluated along two perpendicular 30-meter transects intersecting the nest or random plot center. The orientation of the first transect was randomly determined. The line-intercept method was used to estimate the percent live sagebrush, dead sagebrush (<15% of the plant composed of living stems as determined by the presence of leaves), and total shrub canopy coverage. Dead sagebrush canopy cover was converted to a ratio of total sagebrush canopy cover. To estimate live sagebrush height, the maximum height (cm; excluding flowering stalks) of each intercepted sagebrush plant was recorded. Sagebrush density (plants/meter^2) was estimated by counting the number of sagebrush plants in a 1-meter wide belt along each transect (≥50% of a plant had to be within the belt to be counted).

Vegetation characteristics were measured within a 20 × 50 centimeter quadrat using a canopy-coverage method at the transect intersection (nest), at 1.0 meter, and at 2.5 meter from the intersection along each 15 meter portion of the 30 meter transect radiating from the nest or random center. Herbaceous variables were assumed to represent nest screening elements, and thus were measured relatively close (≤2.5 meter) to the nest to ensure a potential direct influence on nest fate. Herbaceous variables measured included maximum droop height (the highest naturally growing portion of the plant excluding flowering stalks) of grasses, total herbaceous cover, standing grass cover, and forb cover [which included the shrub species winterfat (*Eurotia lanata*) and fringed sagewort (*Artemisia frigida*)]. Grass species were grouped and classified as either new or residual (i.e. standing-dead). Because forbs are important food components of female sage-grouse diets, species were identified and further grouped as either food forbs or non-food forbs according to previous research. Food forb cover was converted to a ratio of total forb cover and examined, thereby providing a measure of relative food forb abundance at the nest site. It should be noted, however, that nearly all forbs are potential food for sage-grouse depending on succulence and stage of growth.

Table 1 depicts vegetation variables collected at nest sites from five studies in Wyoming from 1994 to 2002. Some vegetation variables were not collected at all studies.

To identify early-brood-rearing habitat successful hens were located twice during early brood-rearing stages. The first location was identified at least two weeks following hatch to ensure broods had reached brooding habitat, and allow the hen to become firmly attached to her chicks prior to human disturbance. To ensure that feeding sites were identified, broods were located between sunrise and 8:00 am.

Vegetation measurements were recorded at early brood-rearing habitat and independent random sites in June and July. Independent random sites were determined by randomly generating UTM coordinates for the study area. Vegetation was measured utilizing the same methodology that was used for nesting habitat. Table 2 depicts vegetation variables of early brood-rearing habitats at five study sites in Wyoming from 1994 to 2002, and are directly comparable due to the similarities in data collection protocol.

Tables 3 through 8 show monthly and annual precipitation that was collected at National Weather Service (NWS) collection sites near each study area. These tables also show long term monthly and yearly averages and the number of years that the data was collected for each site. The Pinedale and Big Piney weather stations were used in conjunction with the Pinedale sage-grouse study due to lack of data capture during some periods at the Pinedale location. These data are available on the Western Regional Climate Center web site (http://www.wrcc.dri.edu/).

Table 1. Means and standard deviations for nesting habitat variables qualified by sage-grouse nest and random plots in Wyoming, 1994-2002. T-tests were used to identify the differences between nest use vegetation plots vs. independent random vegetation plots. Bolded variables are significantly different. $\alpha = \leq 0.05$ Values in parentheses are standard deviations.

	Farson		Rawlins		Bates Hole		Pinedale		Kemmerer[1]	
Variable	NEST mean	RANDOM mean	NEST mean	RANDOM mean	NEST mean	RANDOM mean	NEST mean	RANDOM mean	NEST mean	RANDOM mean
Sample Size	82	90	42	61	87	87	50	63	64	77
Live Sagebrush Density (plants/m^2)	**1.85(0.67)**	**1.54(0.60)**	1.92(1.28)	1.60(1.00)	2.51(1.38)	2.43(1.29)	2.04(0.594)	2.38(0.63)		
Dead Sagebrush Density (plants/m^2)	**0.37(0.20)**	**0.30(0.25)**	**0.31(0.18)**	**0.22(0.17)**	0.294(0.15)	0.284(0.15)	0.33(0.190)	0.34(0.165)		
Vertical Obstruction Cover (cm)	26.80(11.78)	25.00(11.38)	47.00(20.09)	45.30(13.28)	0.396(0.18)	0.373(0.13)	N/A	N/A		
Total Shrub Canopy Cover (%)	**29.60(7.74)**	**24.70(10.15)**	**28.60(12.83)**	**23.80(10.31)**	**30.50(11.70)**	**28.60(10.40)**	38.1(11.60)	35.19(7.61)	28.4(11.33)	23.5(10.96)
Live Sagebrush Canopy Cover (%)	**24.40(6.59)**	**19.80(8.79)**	19.00(12.90)	16.60(9.92)	**25.40(10.50)**	**23.89(9.46)**	25.61(9.91)	26.96(5.83)	22.2(11.65)	18.6(9.29)
Dead Sagebrush Canopy Cover (%)	**3.28(2.32)**	**2.46(2.73)**	**3.10(3.05)**	**2.10(2.11)**	**3.14(1.82)**	**2.77(1.57)**	6.78(4.22)	4.95(3.39)		
Average Live Sagebrush Height (cm)	28.70(7.74)	26.60(10.44)	32.60(12.96)	27.40(11.87)	31.40(12.40)	30.70(10.20)	**32.7(11.50)**	**27.63(5.62)**	44.0(16.15)	35.9(17.53)
Residual Grass Height (cm)	7.94(4.29)	7.11(4.08)	**10.60(4.41)**	**7.80(3.36)**	11.73(3.00)	11.48(2.75)	11.46(3.71)	10.25(3.50)		
Residual Grass Cover (%)	**2.33(2.93)**	**1.49(1.49)**	**1.03(1.88)**	**0.44(0.85)**	2.45(1.55)	2.46(1.96)	**4.11(4.39)**	**2.66(0.641)**		
Live Grass Height (cm)	**14.90(3.37)**	**13.40(3.43)**	**16.60(3.56)**	**15.00(3.36)**	18.40(3.73)	17.73(3.95)	21.33(4.25)	21.79(3.59)		
Live Grass Cover (%)	**8.86(5.69)**	**6.67(4.69)**	8.20(4.73)	6.90(4.61)	4.59(2.61)	4.87(3.62)	**10.6(11.7)**	**5.44(3.76)**		
Total Forb Cover (%)	2.31(3.22)	3.27(4.15)	2.04(2.33)	2.11(3.05)	7.34(3.64)	7.18(3.90)	**8.19(9.21)**	**4.33(4.75)**	7.9(6.88)	5.4(5.61)
Food Forb Cover (%)	N/A	N/A	N/A	N/A	1.79(1.47)	1.90(1.57)	N/A	N/A		
Non-Food Forb Cover (%)	N/A	N/A	N/A	N/A	5.55(3.26)	5.28(3.24)	N/A	N/A		
Litter Cover (%)	**10.61(5.86)**	**7.95(5.95)**	**26.10(17.02)**	**18.80(12.57)**	**8.54(3.34)**	**8.86(3.41)**	20.4(12.2)	20(6.97)	28.3(16.00)	21.7(16.00)
Bare Ground Cover (%)	31.90(16.21)	35.66(16.70)	**23.50(14.58)**	**35.10(13.82)**	5.01(5.63)	4.52(4.38)	**28.2(16.9)**	**39.6(12.0)**	19.1(13.67)	27.1(20.19)
Lichen Cover (%)	**1.14(2.30)**	**0.88(1.49)**	N/A	N/A	N/A	N/A	N/A	N/A		
Mat-former Cover(%)	N/A	N/A	0.07(0.20)	0.11(0.39)	N/A	N/A	N/A	N/A		
Total Herbaceous Cover (%)	**21.20(11.95)**	**17.57(10.34)**	12.70(7.53)	10.20(6.56)	29.60(13.70)	31.90(16.20)	**18.5(20.1)**	**9.07(6.41)**	26.2(12.24)	22.3(13.55)
Nest Bush Height	N/A	N/A	N/A	N/A	N/A	N/A	**44.4(24.1)**	**21.4(22.5)**		

[1] Progress Report Data (Preliminary). No significance tests were preformed for progress reports.

Means and standard deviations for early brood-rearing habitat variables qualified by sage-grouse early use and random plots in Wyoming, 1994-2002. T-tests were used to identify the differences between early brood use vegetation plots vs. independent random vegetation plots. Bolded variables are significantly different. $\alpha = 0.05$ Values in parentheses are standard deviations.

	Farson		Rawlins		Bates Hole		Pinedale		Kemmerer[2]	
Variable	USE mean	RANDOM mean	USE mean	RANDOM mean	USE mean	RANDOM mean	USE mean	RANDOM mean	USE mean	RANDOM mean
Sample Size (n)	78	53	16	30	67	160	23	63	13	77
Live Sagebrush Density (plants/m^2)	1.80(0.640)	1.720(0.638)	1.76(1.160)	1.70(1.260)	2.15(1.35)	2.37(1.20)	**1.9(0521)**	**2.3(0.630)**		
Dead Sagebrush Density (plants/m^2)	**0.290(0.180)**	**0.219(0.118)**	0.29(0.240)	0.19(0.110)	0.312(0.24)	0.279(0.19)	0.33(.160)	0.35(0.165)		
Effective Vegetation Height (cm)	N/A	N/A	**36.5(23.60)**	**41.3(12.050)**	N/A	N/A	N/A	N/A		
Total Shrub Canopy Cover (%)	21.60(7.780)	22.26(8.860)	23.5(11.200)	24.6(8.764)	**19.29(9.93)**	**24.07(8.62)**	**30.0(6.30)**	**35.0(7.61)**		
Live Sagebrush Canopy Cover (%)	17.22(6.920)	17.89(8.350)	14.4(8.800)	17.3(10.407)	**15.83(8.67)**	**20.21(8.17)**	**21.5(7.35)**	**27.0(5.83)**	13.5(13.4)	18.6(9.29)
Dead Sagebrush Canopy Cover (%)	1.95(1.730)	1.92(2.680)	2.7(2.760)	2.1(2.136)	2.15(2.02)	2.32(1.57)	4.3(3.01)	4.9(3.39)		
Average Live Sagebrush Height (cm)	27.89(13.090)	25.89(9.730)	33.4(12.000)	26.2(12.598)	25.46(10.24)	26.68(7.82)	29.5(8.83)	27.6(5.62)		
Visual obstruction	0.18(0.070)	0.18(0.070)	N/A	N/A	N/A	N/A	N/A	N/A		
Residual Grass Height (cm)	N/A	N/A	6.6(3.880)	8.4(3.505)	11.11(2.64)	10.90(2.51)	11.3(5.79)	10.3(3.50)		
Residual Grass Cover (%)	N/A	N/A	0.10(0.240)	.33(0.548)	**2.85(1.88)**	**2.01(1.18)**	3.5(3.90)	2.7(0.641)		
Live Grass Height (cm)	N/A	N/A	16.1(4.800)	14.4(2.739)	18.59(4.94)	17.84(3.72)	23.3(4.9)	21.7(3.59)		
Live Grass Cover (%)	6.77(4.280)	6.58(4.440)	12.5(13.200)	5.5(3.286)	5.89(5.74)	4.61(2.44)	14.2(18.1)	5.4(3.76)		
Total Forb Cover (%)	4.07(4.370)	3.22(3.470)	**2.8(2.800)**	**1.6(1.643)**	**9.25(4.93)**	**6.59(3.33)**	8.3(9.91)	4.3(4.75)		
Food Forb Cover (%)	0.46(0.890)	0.31(0.780)	N/A	N/A	3.55(4.34)	1.94(1.57)	N/A	N/A		
Non-Food Forb Cover (%)	3.61(4.190)	2.90(3.500)	N/A	N/A	5.70(2.91)	4.65(2.76)	N/A	N/A		
Litter Cover (%)	8.57(7.120)	7.94(6.340)	**24.7(16.800)**	**20.7(14.788)**	**8.52(2.88)**	**10.12(3.70)**	**13.8(7.25)**	**20(6.97)**		
Bare Ground Cover (%)	36.70(15.080)	33.87(17.210)	**17.4(9.00)**	**37.6(5.60)**	7.30(4.90)	7.62(7.82)	**23.5(17.8)**	**39.6(12.00)**		
Mat-former Cover (%)	N/A	N/A	0.4(1.600)	0.1(0.548)	N/A	N/A	N/A	N/A		
Total Herbaceous Cover (%)	15.48(9.720)	15.86(10.220)	**16.9(16.800)**	**7.8(4.930)**	**37.25(15.0)**	**29.36(14.45)**	**24.8(23.9)**	**9.07(6.41)**		

[2] Progress Report Data (Preliminary). No significance tests preformed.

Table 3

FARSON, WYOMING

Monthly Total Precipitation (inches)

(483170)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1993	0.38	0.27	0.30	0.00z	1.56b	2.50c	1.80e	0.84d	0.15	0.51b	0.74b	0.20	9.25
1994	0.17a	0.61	0.57	0.00z	0.25	0.15	0.10	0.60	0.46	1.11d	0.44a	0.15	4.61
1995	0.50	0.54	0.83a	1.52a	4.03a	1.17b	0.88b	0.72	0.74	0.10	0.15	0.30	11.48
1996	0.16g	0.24	0.34	0.00	1.61c	0.79	0.62	0.00	1.18a	1.32b	0.00z	0.00z	6.10
MEAN	0.39	0.38	0.46	0.71	1.05	0.94	0.67	0.66	0.72	0.66	0.38	0.33	**7.73**
S.D.	0.34	0.33	0.40	0.56	0.90	0.88	0.77	0.66	0.68	0.57	0.32	0.27	2.38
No. YRS	72	77	77	76	75	74	68	73	69	73	71	71	49

Table 4

RAWLINS FAA AIRPORT, WYOMING

Monthly Total Precipitation (inches)

(487533)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1995	0.39	0.38	0.32	1.23	4.12a	2.19	0.26a	0.55	0.85	0.60	0.44	0.48	11.81
1996	0.71	0.08	0.76	1.64	3.14	0.36	0.56	0.19	0.52	0.54	0.74	1.10	10.34
1997	0.65	0.39	0.24	1.11	1.13	1.62	0.21	1.62	1.22	0.38	0.27	0.38	9.22
MEAN	0.49	0.53	0.68	1.05	1.33	0.91	0.76	0.75	0.80	0.82	0.58	0.48	**9.28**
S.D.	0.33	0.38	0.41	0.62	0.88	0.67	0.59	0.52	0.65	0.69	0.40	0.33	1.89
No. YRS	51	50	50	51	51	51	51	50	51	51	52	52	49

Table 5

Bates Creek 2, WYOMING

Monthly Total Precipitation (inches)

(480552)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1996	0.66	0.14a	0.43	2.93	2.00	0.80	1.03	0.58	0.59	3.43	1.23	0.61	14.43
1997	1.29	1.70	0.48	1.50	3.01	1.23	0.79	1.76	0.89	1.04	0.02a	0.82	14.53
1998	1.08	0.91a	0.83	0.75	0.54	3.54	1.24	1.00	0.97	6.44	0.74b	0.08	18.12
MEAN	0.6I	0.66	1.05	1.65	2.22	1.35	1.06	0.91	0.82	1.27	0.74	0.58	**13.14**
S.D.	0.33	0.37	0.77	1.25	1.77	0.99	0.66	0.61	0.61	1.25	0.39	0.46	2.84
No. YRS	33	33	33	33	34	34	34	34	34	34	33	33	32

Table 6

PINEDALE, WYOMING

Monthly Total Precipitation (inches)

(487260)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1997	0.62	0.17	0.35	0.62	0.76	1.96	0.42	1.91	1.98	0.61	0.22	0.19	9.81
1998	0.98	0.48	1.29	0.59	2.02	3.93	2.59	0.78	0.96	1.02	0.29	0.50b	15.43
1999	0.68	0.68b	0.00z	2.37a	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	3.73
MEAN	0.64	0.51	0.63	0.87	1.62	1.25	1.02	1.02	1.10	0.77	0.71	0.65	**11.26**
S.D.	0.44	0.32	0.41	0.54	0.97	0.94	0.69	0.62	0.71	0.63	0.46	0.50	3.13
No. YRS	49	48	49	49	48	51	53	52	52	49	47	47	37

Table 7

BIG PINEY, WYOMING

Monthly Total Precipitation (inches)

(480695)

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

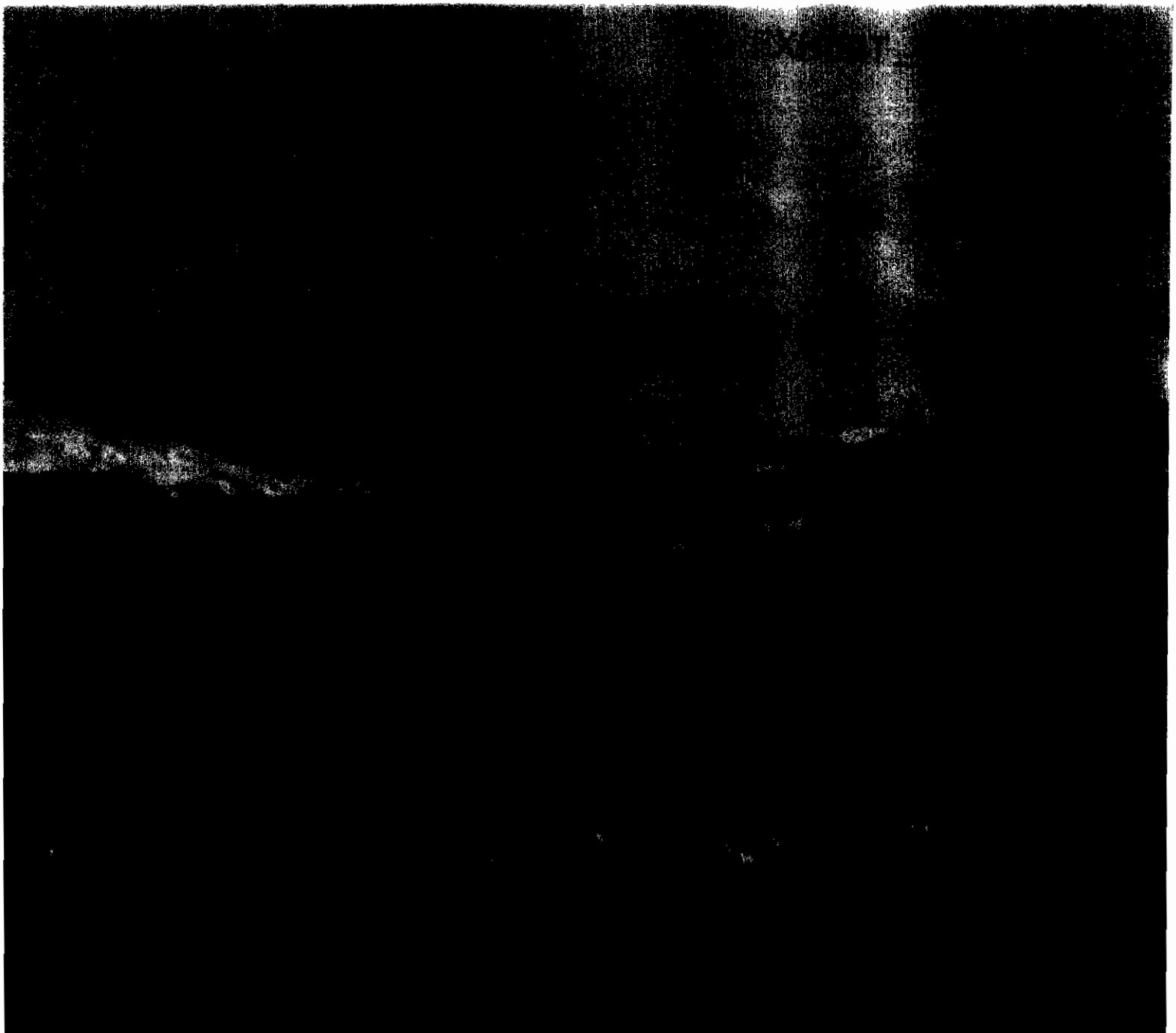
YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1997	0.56	0.08	0.14	0.20	0.07	1.03	1.26	3.82	1.24	0.53	0.21	0.35	9.49
1998	0.46	0.44	1.09	0.63	1.32	2.41	0.98	0.99	0.49	1.28	0.17	0.03	10.29
1999	0.28	0.52	0.00z	0.00z	0.82	0.86a	0.44	0.67	1.21	0.03	0.00a	0.01f	4.83
MEAN	0.37	0.31	0.44	0.65	1.05	0.92	0.74	0.81	0.84	0.55	0.38	0.39	**8.15**
S.D.	0.29	0.27	0.33	0.51	0.84	0.79	0.44	0.75	0.70	0.58	0.30	0.34	2.07
No. YRS	45	43	44	46	46	45	43	46	48	47	45	42	29

Table 8
KEMMERER WTR TRTMT, WYOMING
Monthly Total Precipitation (inches)
(485105)

*** Note *** Provisional Data *** After Year/Month 200210
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
2000	0.04	0.00	0.00a	0.00	0.00	0.00	0.51	0.80	1.22	0.00z	0.00z	0.00b	2.57
2001	0.00	0.16a	0.00	0.40	0.89	0.30	0.97	0.25	0.69	0.40	0.40	0.60	5.06
2002	0.79	0.00	0.37	0.00z	0.42	0.01	0.21	0.04	0.38	1.12	0.00z	0.00z	3.34
MEAN	0.75	0.59	0.65	0.82	1.17	1.11	0.74	0.87	0.99	0.77	0.82	0.71	**10.26**
S.D.	0.43	0.53	0.47	0.63	0.72	1.05	0.55	0.79	0.95	0.61	0.66	0.62	3.55
No. YRS	52	52	53	50	53	50	52	52	50	50	52	52	39

EXHIBIT D



WILDLIFE CONSERVATION SOCIETY

JANUARY 2006

WILDLIFE & ENERGY DEVELOPMENT

Pronghorn of the Upper Green River Basin - Year 1 Summary

By Joel Berger, Kim Murray Berger, Jon P. Beckmann

Project Funding by Shell Exploration and Production Company, Ultra Petroleum, Anschutz Petroleum,
and
The Wildlife Conservation Society

The Wildlife Conservation Society

The Wildlife Conservation Society (WCS) is dedicated to saving wildlife and wildlands to assure a future for threatened species like elephants, tigers, sharks, macaws, or lynx. That mission is achieved through a conservation program that protects some 50 living landscapes around the world, manages more than 300 fteld projects in 53 countries, and supports the nation's largest system of living institutions – the Bronx Zoo, the New York Aquarium, the Wildlife Centers in Central Park, Queens, and Prospect Park, and the Wildlife Survival Center on St. Catherines Island, Georgia. We are developing and maintaining pioneering environmental education programs that reach more than three million people in the New York metropolitan area as well as in all 50 Unites States and 14 other countries. We are working to make future generations inheritors, not just survivors.

To learn more about WCS visit www.wcs.org.

WCS has been an active force in North American conservation since 1895. Bison reintroduction, legislation to protect endangered wildlife, and the establishment of more than twenty parks and reserves were early WCS accomplishments. Pioneering studies of bighorn sheep, elk, cougars, and wolves all benefited from WCS support. Today the WCS North America Program takes a science-based approach to conservation in more than forty projects in twenty-one states and provinces. Key issues include reserve creation, wildlife monitoring and recovery, ecosystem restoration, integrated landscape management, and community-based conservation.

To contact the North American Program write to: nap@wcs.org.

January 2006

Wildlife and Energy Development

Pronghorn of the Upper Green River Basin – Year 1 Summary

Joel Berger[1], Kim Murray Berger[1], Jon P. Beckmann[2]

[1] Teton Field Office, Wildlife Conservation Society, PO Box 985, Victor, ID 83455
[2] Great Plains Field Office, Wildlife Conservation Society, 1109 N. Lark, Wichita, KS 67212

2300 Southern Boulevard
Bronx, NY 10460